

The old-fashioned methods of slaughtering which are employed in the case of about fourteen million animals yearly in Great Britain are broadly as follows: Large animals before being killed are stunned with a poll-axe; pigs are hoisted with a chain attached to one hind leg and stuck, commonly without previous stunning; many calves and some pigs are first stunned with a hammer; occasionally sheep and lambs are similarly stunned, but usually they are lifted on to a 'crutch' or trestle and stuck with a knife while conscious, after which their necks are broken by pressing back the head, the spinal cord being sometimes cut with the knife; Jewish slaughterers, for reasons of ritual, first throw the animal and then cut its throat in every case. The modern method, which is at present used for about one million animals yearly in Great Britain, consists in preliminary stunning with a specially designed pistol, after which the animal must be immediately bled.

From the humane point of view the superiority of the pistol over the poll-axe has been placed beyond serious question by the experiments conducted on behalf of the Corporation of London by the Medical Officer of Health (Dr. W. J. Howarth), the Superintendent of the Metropolitan Cattle Market (Mr. J. R. Hayhurst), and the Veterinary Surgeon at the Central Meat Market (Lieut.-Col. T. Dunlop Young). These officers found, in a number of trials with careful and experienced slaughtermen, that it took on the average 2.49 blows with the poll-axe to stun a bull, 1.23 blows to stun a steer, 1.27 to stun a cow, and 1.55 to stun a large sow or boar. With careless or less experienced slaughtermen the results would have been still less favourable. On the other hand, with a particular captive-bolt pistol, 542 bovines were stunned with 543 shots and 712 swine were stunned with 715 shots. Starling and Foster found that when the throat is cut with exceptional skill (in the Jewish method) the duration of consciousness, as tested by corneal reflex and by purposiveness of movement, varies from 5 to 40 seconds, with an average in the neighbourhood of 20 seconds. The qualitative superiority of the pistol over the knife, from the humane point of view, may be regarded as established, though there is some difference of opinion as to the quantitative aspect of the matter. However, Sir Arthur Mayo-Robson has described an important post-mortem test which does not appear to have been applied in the investigations under consideration: it consists in examining the meninges. Dr. Pfister, Director of the Zurich Abattoir, has found that when animals have been

stunned before killing their meninges are normal, whereas in animals killed without stunning, as many millions are in Great Britain, the meninges are intensely congested, a fact which proves that suffering has occurred. Finally, the use of the knife has to be learned by practising upon living animals.

The captive-bolt pistol does not involve danger to the slaughterman or to bystanders, and its use calls for only such reasonable care as may fairly be demanded from a tradesman. The meat traders' federation collected for the London County Council inquiry 15 examples of alleged accidents occurring with 'humane killers' between 1913 and 1920, but of these 5 turned out to be cases of suicide and 4 to be otherwise irrelevant. Of 5 genuine and 1 suspectedly genuine accidents, 5 occurred with pistols of the free-bullet as distinct from the captive-bolt type, and in the remaining case the type of pistol was not specified.

There are, however, other considerations which cannot be quite so easily dismissed. The most difficult of these is the allegation that pigs do not bleed so freely when shot as when killed by the old-fashioned methods, and that shot pigs are therefore less valuable for the manufacture of export bacon. It is also alleged that the flesh of shot pigs is more liable to be disfigured by 'blood splash.' The Corporation of London's research negatives the second of these allegations but leaves the first undecided: not only scientific authorities but also those engaged in the trade are divided on the subject, and further trials are called for. Doubtless a great deal depends on the precautions taken to promote bleeding immediately after shooting. In any case, it should be borne in mind that in large factories the pigs, when hoisted, are attached to a travelling conveyer, and owing to the weight of the animal the pressure of the chain on the leg will cause suffering, apart from the use of the knife.

In the case of sheep the difficulty is somewhat different. If a sheep be lifted on to the crutch and then shot, its struggles are said to make manipulation of the pistol more difficult than that of the knife. If, on the other hand, it be shot on the ground, the labour of lifting it on to the crutch afterwards is increased. Thus a 7-handed gang slaughtering 100 sheep a day might need an extra hand, whose wages would possibly amount to 12s. 6d. a day. The increased cost of production would therefore be about 1½d. per sheep, or 0.025 pence per lb. of mutton. Such a small expense should not be allowed to obstruct the

doing of what is clearly just and right; Switzerland, Holland, Germany, Sweden, and Denmark have set an example which Great Britain could follow.

In the Jewish method of slaughter, which is governed by a traditional ritual, the animal is first cast, after which its throat is cut with exceptional skill and elaborate precautions. From the humane point of view throat-cutting is not so satisfactory as stunning, but the most serious objection to this method is the preliminary casting, which in the opinion of Starling and Foster involves definite cruelty, sometimes of a serious character. The Jews are by nature and tradition a humane race, and it should not be impossible for their experts to devise some modification of the procedure which will satisfy all the requirements of the situation. Indeed, so recently as Mar. 17 an important test was held at Brixton of a new apparatus designed by Mr. H. Weinberg to obviate the cruelty involved in casting. It is understood that a number of veterinary surgeons who were present were satisfied that a great advance has been made, and it is to be hoped that mercenary interests will not prevent Mr. Weinberg's apparatus from receiving a more extensive trial.

The compulsory training and licensing of slaughtermen is a pressing requirement, for while most slaughtermen are fully trained before they use the poll-axe, there is no adequate provision for the enforcement of this elementary precaution against the infliction of unnecessary suffering. But perhaps the most serious defect of our slaughtering system, both on humane and on hygienic grounds, is the lack of adequate control and inspection of slaughterhouses. In the more advanced of the Continental countries, private slaughterhouses have been extensively replaced by public abattoirs, but unfortunately in Great Britain private slaughterhouses still exist, and their licences have a capital value which opposes a strong vested interest to the movement for reform. The financial cost of doing what is right in this case is by no means an inconsiderable one. Obviously, however, the element of fear can be much diminished in a properly designed public abattoir, which also facilitates supervision for humane and hygienic ends. Hence public abattoirs alone are tolerable in towns, while in country districts a rigorous system of inspection and control by public officers is called for. The hardship which would be inflicted on the "slink" trade in meat from tuberculous animals could be softened by a good system of insurance.

It will be seen that while a very substantial body

of facts may be regarded as established in connexion with humane slaughtering, there are other facts—and particularly as regards the effect on the quality of bacon and the psychological element in the suffering of the animals—which call for authoritative investigation. It is essential that the experimental work involved should be carried out by disinterested scientific men, adequately familiar with the canons of scientific method. However, apart from prejudice and conservatism and the professional pride taken by slaughtermen in a highly skilled trade, which they have learned by long apprenticeship, the opposition to reform is based on mercenary considerations. Even if the shot pig should prove to be somewhat less valuable for export bacon than the pig which has been more painfully killed, the question will arise whether the economic motive should prevail over the ethical.

The Ministry of Health proposes two alternative by-laws for adoption by local authorities, but does not enforce their acceptance. By-law 9a requires that all slaughterers except Jews shall stun the animal before killing it, except in the case of sheep. By-law 9b is similar, but it applies also to sheep and specifies the use of a mechanically operated instrument—that is, in practice, a pistol. Out of some 2000 local authorities only 226 (including the London County Council) have hitherto adopted the stricter by-law, though the number is growing in response to propaganda by the Royal Society for the Prevention of Cruelty to Animals, the Humane Slaughter of Animals Association, and other humanitarian bodies. The adoption of the by-law may put a district at an economic disadvantage in its competition with neighbouring districts for the patronage of butchers, many of whom are prejudiced against the pistol. The Sanitary Committee of the Corporation of London has therefore passed a resolution to the effect that the time is now opportune for the issue of definite regulations which should be of general application throughout Great Britain, and that "in order to secure uniformity such regulations should be issued as compulsory regulations by the Ministry of Health." Presumably the Government will hesitate to take the necessary action until it feels itself supported by a well-informed public opinion, but the subject is an unpleasant one, and the public naturally prefers to know as little of it as possible. In the face of this situation, no apology is needed for having brought it to the attention of scientific men, who are *ex hypothesi* opposed to obscurantism.

C. W. HUME.

Science and Psychic Behaviour.

The British Journal of Psychical Research. Vol. I. No. 5. Jan.-Feb. (London: National Laboratory of Psychical Research, 1927.) 1s.

THE accusation is frequently levelled at scientific workers that they will give no thought or credence to the very real phenomena of the supernatural, and that this attitude of aloofness sits ill on those who profess the true scientific spirit. That there is truth in the charge can scarcely be gainsaid. When Sir Oliver Lodge pronounces on a modern development or even a modern speculation of molecular physics, the auditorium is filled with craning necks and assenting minds, but let him turn to the subject of materialisations or the after-life, the scientific necks are relaxed and the minds closed. It is worth while inquiring why this conspiracy of hostile silence is maintained.

It is a truism that trustworthy scientific work can be accomplished only by trained minds after elaborate preparation for a line of attack based on a close study of the problem. For in all circumstances the question at stake is the question of what is and what is not admissible evidence. The scientific process is the method of collecting and assembling that evidence, and no deduction will stand that allows of possible ambiguity or for which the evidence is not both necessary and sufficient. Even legal standards are not permissible. The final conclusion cannot be based on circumstantial evidence, nor does one give an electron the benefit of the doubt. The logic of the law court is not necessarily the logic of the laboratory.

In these circumstances it is permissible to doubt that any individual, no matter how well intentioned, could sail into a notoriously difficult region of inquiry and produce almost immediately astounding results of full evidential value. Even were the individual a trained scientific investigator, there is a natural hesitancy in acceptance, for independent verification by other workers is a necessary and legitimate demand. The difficulty is accentuated when the scientist who undertakes or is present at the inquiry is constrained to work under conditions and limitations the full implications of which cannot be precisely appreciated. The phenomenon, he may be told, will take place only in darkness, or in dull red light, or in the presence of a particular individual or a group of individuals, or when a gramophone plays in the subdued light of a vacuum tube discharge, and so on. If, moreover, the events described as occurring, when accepted, would involve a complete reconsideration of the

structure of mechanical processes, reluctance to admit that the evidence is above criticism is naturally intensified.

These are the difficulties one encounters with most of the material in the publication before us. If the merest fraction of the evidence adduced in this small volume were to be admitted it would cause a revolution in scientific thought. In a lecture delivered at the National Laboratory of Psychical Research, Countess Wassilko-Serecki describes the history—one is almost tempted to write the hysteria—and phenomenon of Eleonore Zügun, a Rumanian peasant girl. In the presence of this girl inanimate objects become endowed with a will of their own, bricks fly about, dishes dash themselves to pieces, a stone jumps out of the river, is replaced and jumps out again, scratches and bites appear on her arm, cups are snatched from her hand by invisible powers, and so on. A great deal of the evidence for this is not direct but produced by the Countess from depositions of individuals abroad. Dr. R. J. Tillyard contributes a record of two séances conducted by a medium in Boston, Mass. Here darkness appears to be essential, and the medium goes into a trance. This is verified at intervals by red light. It would be interesting to have details of the verification of this trance condition conducted in such difficult circumstances, but they are not provided. A gramophone plays a negro melody and a voice—immediately referred to as 'Walter's' voice—talks "freely and wittily" apparently from inside a cabinet. The humour does not, however, appear to be very deep. A flower basket—rendered luminous—moves about high up in the room, rocked by 'Walter,' we are told, but no evidence is adduced about 'Walter' beyond the voice, or as to whether the basket was actually rocked by him.

Much could be said about this kind of science, but restraint is desirable. Numerous questions naturally suggest themselves. If a brick can fling itself through a window, what reliance can be placed on the prediction of the total eclipse in June? What reliance can be placed on the performance of *any* machine? Alternatively, if, as experience shows, full reliance can be placed on a multitude of such predictions, what reliance can be placed on the evidence about the brick? Scepticism becomes charity indeed. There is here a frank conflict of evidence, and until it is resolved the scientist's natural inclination is to turn back to the restful haven of verified knowledge. If there are inconsistencies in his own field, if for the moment he cannot reconcile solar mechanics with

the mechanics of the electron, his past experience has at least taught him that with patience these troubles will be smoothed. Consistency of behaviour of his material, however, is implicit in his method of approach. Such an assumption may possibly prove to be ill-founded, and the self-propulsion of the brick through the window, referred to above, may ultimately prove to be the actual disturber of his mental peace. But his *malaise* in the presence of such a phenomenon—if true—goes deeper than this. "If the material with which I have to deal," he says, "is not consistent in its behaviour, how can I study the question at all?"

It seems to be inevitable in experiments in this field of inquiry—if they can be called experiments—that a great deal must depend on the good faith of the medium. There is always the lurking suspicion that, consciously or unconsciously, the observers are being deluded—a factor utterly foreign to any class of physical experiment. This suspicion is traceable not so much to the fact that, in the past, trickery has been exposed in the performances of such individuals, as to the fact that results are claimed of a nature antagonistic to the tacit philosophy of the physicist. To meet this difficulty, one of the first tests that ought to be performed should be to determine the precise conditions under which a medium can be dispensed with. Quite obviously, the smaller the number of persons actually essential to an experiment, the greater the confidence in the result. Is it not possible for the National Laboratory of Psychical Research to produce the details of a single and convincing experiment that could be performed by any competent scientific worker in his own laboratory, as simple, say, as measuring the period of a pendulum? If 'levitations' are as frequent as they are claimed, this should not be impossible. The writer has frequently tried such experiments alone, but always in vain. What are the conditions that will ensure success? Surely, after so many years' experimentation by devotees of the cult, including many eminent men, this must be known very accurately. All the tests described in the publication under review are so complex that instead of carrying conviction they arouse suspicion. It is the simple test that is required.

There is, however, another—and possibly more important—factor that repels the scientist: it is the implications and assumptions inherent in the descriptions of these uncanny doings. If a voice is heard speaking from a box, is it necessary to assume it has an owner, 'Walter'? In a court of

law it might be a legitimate assumption to make, and it might in conceivable circumstances be sufficient to hang a man, but in the description of a scientific experiment, why imply the existence of an 'owner' to the voice and by identifying it with 'Walter'? Even assuming the accuracy of the phenomenon, which in the circumstances one would be far from doing, there are numerous possible working hypotheses of a more normal type than that of 'spirits.' When Sir Richard Paget makes his hands speak, one does not assume that the voice belongs to a spirit, even if it does call itself 'Walter.' Men of science have learnt that words are treacherous things, that false ideas of an ignorant past are dragged in at each turn, so they have learned to talk in symbols, with a clear-cut (1, 1) correspondence between idea and symbol. But the language of supernormal behaviour—and the very phrase itself is dangerous—is not yet sufficiently divorced from mystery and superstition, not yet sufficiently definite and precise, to ensure that the pet theories and vague beliefs of its devotees are not foisted on the unwary inquirer as he receives his description of the phenomena.

If the National Laboratory of Psychical Research can produce a simple laboratory experiment, capable of being performed by a careful and trained scientist under conditions that he himself can guarantee and control, it would go further towards producing the revolution in thought which the Council so earnestly desires than volumes of 'evidence' of the type given in the present issue of its Journal.

H. LEVY.

Dynamics and Ballistics.

- (1) *Lezioni di meccanica razionale*. Per Tullio Levi-Civita e Ugo Amaldi. Volume secondo: *Dinamica dei sistemi con un numero finito di gradi di libertà*. Parte prima. Pp. x+527. (Bologna: Nicola Zanichelli, 1926.) 65 lire.
- (2) *New Methods in Exterior Ballistics*. By Prof. Forest Ray Moulton. Pp. vi+258. (Chicago: University of Chicago Press; London: Cambridge University Press, 1926.) 20s. net.

(1) **T**HE monumental treatise which Profs. Levi-Civita and Amaldi are engaged in writing on rational mechanics (to use the comprehensive title established on the Continent) is divided into three volumes, which deal respectively with kinematics and statics, dynamics of systems possessing a finite number of degrees of freedom, and dynamics of continuous systems. The second volume is divided into two parts, to the second of

which are reserved the general questions properly belonging to rigid dynamics and the subjects of canonical equations of motion and the principle of Hamilton and Jacobi.

The plan of the first part of the second volume is as follows: The first two chapters discuss the motion of a particle constrained to move on a given curve and on a given surface. The third chapter deals with problems of gravitational attraction. General theorems on momentum, energy, and work are treated in Chapter iv. D'Alembert's principle and Lagrange's equations occupy Chapter v., and the volume closes with a chapter on stability of motion and small oscillations.

Chapter iii., which is mainly concerned with celestial mechanics, contains interesting applications to planetary orbits according to Einstein's law of gravitation and to electronic orbits according to Bohr's atomic theory. The motion of electrons in an electromagnetic field also furnishes interesting examples. It is, indeed, a refreshing change to discover so little space devoted to questions better fitted to exercise a student in integration than in dynamical principles.

Into the time-worn problems to which so large a proportion of any work on dynamics must be consecrated it would be difficult to introduce much originality of treatment. Yet throughout this work, Profs. Levi-Civita and Amaldi have succeeded in revivifying these 'dry bones' by a continual slight novelty, most stimulating to the reader. The work is planned on generous and comprehensive lines and covers ground scarcely touched in any similar treatise. It even contains a fair number of exercises for the student.

(2) Prof. Moulton's short account of some methods of external ballistics discusses the three main problems of the effects of air resistance, rotation of the projectile, and minor factors such as winds, on the projectory. The effect of air resistance is studied by the methods of finite differences, extensively used by Bashforth in England during the last century. The effect of abnormal air densities, variations in gravity, winds, etc., is studied by the method of perturbations, so widely used in astronomy. The effect of rotation is discussed by means of the classical equations of Euler. The book contains no reference to the pioneer work of Bashforth or to the work of Siacci. Few of the methods given appear to be new, and a remarkable new method due to Whitehead ("Graphical Solution from High-Angle Fire," *Proc. Roy. Soc.*, 1918) is not mentioned. It seems that the title of the book is scarcely an accurate description of its

contents. Considerable interest therefore attaches to an ingenuous admission in the introduction. "In view of the complete independence of the present developments from those that have gone before, no attempt has been made to treat the question historically, nor even to connect these results with those of earlier writers." This is an explanation, if not an excuse.

Animal Nutrition in Sweden and Denmark.

Fütterung der Haustiere: ihre theoretischen Grundlagen und ihre wirtschaftliche Durchführung. Von Prof. Nils Hansson. Übersetzt von Franz von Meissner; überarbeitet und mit einem Vorwort versehen von Prof. Dr. Georg Wiegner. Pp. xii+230. (Dresden und Leipzig: Theodor Steinkopff, 1926.) 8 gold marks.

THE science of animal nutrition is concerned with the principles underlying the economical transformation of the produce of the soil into articles of human diet like meat and milk. The elucidation of these principles depends on a knowledge of two sets of factors: first, the nutritive requirements of the different classes of farm stock for the purposes of maintenance and of production (e.g. growth, fattening, and milk production); and secondly, the capacity of the various feeding stuffs for supplying these requirements.

It is instructive to note how these problems have been attacked in Germany and the United States on one hand, and in the Scandinavian countries on the other. In Germany the well-known investigations conducted by Kellner on fattening oxen in the respiration calorimeter have led to the formulation of a system of starch values, in which the productive or, more strictly speaking, the fattening value of a feeding stuff is defined in terms of pounds of starch. Kellner's system has been widely adopted in Britain, where, within limits, it has given useful results, though criticism of the method at the present time is not lacking. Armsby in the United States, also working with fattening oxen in a respiration calorimeter, has evolved a system of net energy values in which the productive value of a feeding stuff is stated in terms of therms of energy.

In northern Europe, however, where dairy cows, and not fattening oxen, have been mainly employed in feeding investigations, it has been the custom to take milk production as a measure of the productive value of a feeding stuff. Experiments on these lines were first started by Fjord at Copenhagen so long ago as 1885, and since 1898

these have been continued and expanded in a series of fundamental researches carried out by Nils Hansson at Stockholm. From the results of these feeding trials came the conception and development of the Scandinavian food unit system, which is now accepted as the basis of feeding in Sweden, Denmark, Norway, Finland, Poland, and other countries. This system, based on Hansson's data, has undoubtedly, in its application to feeding practice, achieved a larger measure of success in northern Europe than has any other system in any other country, and to its adoption must be attributed in no small degree the vast growth of the butter export trade of Denmark and the enormous increase in milk production in Sweden and other northern lands.

Prof. Hansson's main work, "*Handbok i Utfodringslära*," was published in three parts and contained a detailed account of the development and application of the food unit system. The present volume appeared in 1922 under the title of "*Husdjurens Utfodring*" and brought together all the essential features of the "Handbook" in carefully condensed form. Unfortunately, not many English workers are able to read Swedish with any degree of ease, and this fact probably explains the somewhat tardy recognition of Hansson's ideas in Britain. The translation of "*Husdjurens Utfodring*" into German is the direct outcome of a widespread desire among German nutritional scientific workers to know more about a feeding system which has proved so successful in other countries.

The treatment of the subject is characterised by the simplicity and logical clearness for which Hansson's publications are justly celebrated. The first section opens with an account of the composition and digestibility of feeding stuffs, the concluding chapter of this section dealing with the different methods of assessing productive values. The English reader will be particularly interested in the comparative account of the Hansson food unit, the Kellner starch value, and the Armsby net energy value. In the second section the nutritive properties of the individual feeding stuffs are dealt with, while the third and concluding section is devoted to a thorough consideration of the scientific principles underlying the nutrition of calves and other young animals, of dairy cows and fattening oxen, of sheep, pigs, goats, and horses. The tables at the end of the book constitute a praiseworthy feature. Table I. gives the average composition and digestibility of a very large number of feeding stuffs, together with their

productive values in terms of food units, starch values, and milk-producing values. In Table II. the nutritive requirements of all classes of farm stock are recorded in great detail.

It is to be hoped that the translation of Hansson's treatise into English will not long be delayed. Affording as it does a fresh and hopeful outlook on the problems of the economical feeding of farm animals, especially of dairy cattle, it should prove a worthy companion volume to the well-known treatises of Kellner and Armsby and the more recently published text-book of the Cambridge worker, Prof. T. B. Wood. It should be read with interest and profit not only by the investigator in this domain of science, but also by all stock-breeders who are desirous of rearing their animals in accordance with accepted scientific principles.

H. E. WOODMAN.

Our Bookshelf.

Delusion and Belief. By Prof. Charles Macfie Campbell. Pp. v + 79. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 6s. 6d. net.

THIS is an interesting study of the relation of the various beliefs which men have held at different times to their conduct of life. The method of treatment begins with the biological study of belief, pointing out how, although we cannot tamper experimentally with our fellows in regard to the main issues of human life, yet Nature does not shrink from exposing men to the most searching tests.

Various beliefs are discussed which are concerned with topics of high emotional value, such as bereavement, unsatisfied love, and ungratified ambition, and it is pointed out and examples are given of the way in which the attitudes and beliefs of the individual have a strongly subjective note. In the latter part of the book, man's general belief concerning the mechanism of Nature and the order of the cosmos is discussed. Here again the personal viewpoint is noted. The question of the mental health of the individual and the group depends largely on the underlying scheme of values.

The book concludes with a discussion of what the author terms inferior beliefs about health, such as Christian science. Although admitting the personal comfort in some cases, he maintains that any increased efficiency is largely due to adopting the healthy attitude that, even when there is some physical ailment, it is often better to ignore it and to go on playing the game of life. He also points to the danger of inferior beliefs about social problems, such as that of the optimist who talks of universal peace and often denies the existence of harsh realities and hatreds. The belief in the spiritual order of the universe is an important driving force, but it must also be associated with the workaday world. Although tolerant of

various beliefs, Prof. Campbell's conclusion is that instead of discovering something absolute in the realm of belief, one finds that beliefs are the tools of life rather than rare intellectual products to be cherished carefully for themselves. H. D. A.

Tribal Dancing and Social Development. By W. D. Hambly. Pp. 296 + 26 plates. (London: H. F. and G. Witherby, 1926.) 21s. net.

MR. HAMBLY has surveyed dancing and music as a communal activity and expression of emotion literally from the cradle to the grave, for he begins with the celebration of a birth and ends with the dance which follows death—often long after death, like the dance in the Nicobarese ceremony of disinterring the dead and collecting their bones. He does not concern himself with the individual or merely exhibition dancing as such, although in some of the Eastern dances it would be difficult to draw the line—for example, the whipping dance as a test of endurance as performed in the Sudan which he describes—and it would be easier to discriminate even in this case if it were possible to trace whether or not there were any possible connexion with the whipping ceremony sacred to Artemis, which was once celebrated at Sparta.

Important as it may be to consider dancing as a tribal or group activity, as an expression of an emotion, in ultimate analysis, it must be individual; and the same applies to music. In both cases, fundamentally, the appeal is to the rhythmic sense. Even in music, melody appears to be secondary. Those who have heard real savage music know what a wild appeal to the emotions can be made by the mere rhythmic beating of a drum; while the effect of modern dance music, undeniably, however much it may be disliked, lies in its beat and not in its tune. An analysis of the dance, whether individual or communal, as an effect of rhythmic appeal, has yet to be written.

Mr. Hambly's treatment is on more objective lines. His survey of the facts is a useful study of the geographical distribution and character of the dance as an element in ceremonial, which will be invaluable to the student and at the same time serve to bring home to those whose interest is least specialised, its importance as a social factor which, if not approached sympathetically in administration, might give rise to infinite difficulty.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated The Year Book of Photography and Amateurs' Guide and The Photographic Annual, 1927. Edited by George E. Brown. Pp. 820 + 31 plates. (London: Henry Greenwood and Co., Ltd., 1927.) Paper, 2s. net; cloth, 3s. net.

THIS is no longer an almanac, except in name, for that particular feature of the annual has been omitted since a year or two ago, presumably because it was not appreciated. We appreciated it and often turned to it. After four articles dealing with the use of reflex cameras, arranging

snapshots, developing and printing amateurs' films, and the use of 'chlorobrom' papers, follows the valuable "Epitome of Progress," which is a concise and classified history of photography for last year. It includes a very brief summing up of the most striking advances, the events of the year, besides trade and legal items. The largest section of the epitome concerns apparatus, equipment, and processes, and consists of abstracts of the accounts of these that appeared during the year, with all necessary formulæ and many illustrations. After the obituary, 65 pages of formulæ and instructions for the current photographic operations, and 40 pages of tables, comes a section of miscellaneous information. This last includes an excellent "History in Brief" of photographic and photomechanical processes, and various directories. With the text are 30 photogravure reproductions of photographs by some of the most noted workers. The annual fully maintains the unique position that it has earned for itself during its sixty-seven years of issue.

Three Lectures on Atomic Physics. By Prof. Arnold Sommerfeld. Translated by Dr. Henry L. Brose. Pp. iv + 70. (London: Methuen and Co., Ltd., 1926.) 2s. 6d. net.

IT is encouraging to find that these important lectures by one of the most prominent authorities on spectroscopy, delivered under the auspices of the University of London, are now accessible to all in English. They deal with the spectra of hydrogen and helium, and then proceed to the study of complex spectra such as manganese, iron, nickel, and palladium in the light of Pauli's "Principle of Uniqueness." The third lecture gives some much-needed information concerning the structure of crystals, from the point of view of the quantum theory.

The translation is carefully done, but errs on the side of literalness. The translation of *Grundzustand* as 'ground state' is scarcely English, while *abgeschlossen* as applied to systems of elements is 'self-contained' rather than 'completed,' and 'quantize' is rather more exotic than 'quantify' would be.

New Conceptions in Colloidal Chemistry. By Prof. Herbert Freundlich. Pp. vii + 147. (London: Methuen and Co., Ltd., 1926.) 6s. net.

THIS volume contains eight lectures delivered by the author in America in 1925. They deal in a masterly manner with the progress made along certain lines in colloid chemistry during the last few years, and indicate that such matters as adsorption, electrolyte coagulation, and the electrical and optical properties of colloidal systems are not so simple as they were once thought to be. The ample bibliographies, although impartial, show how fundamental is the work of Prof. Freundlich himself, who is to be congratulated on the rare gift of making his discoveries intelligible in two languages, for a German version of the book has already appeared. P. C. L. T.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Constitution of Mercury Derived from Coal Tar.

It will doubtless be a surprise to many readers of NATURE, as it was to me, to hear that the element mercury is obtained in the distillation of coal tar. This fact was recently brought to my notice by Mr. W. Kirby, of the South Metropolitan Gas Co., who kindly provided me with a sample for examination of its isotopic constitution. He informs me that the mercury appears in the lightest of the fractions distilled and occurs to the extent of about one part in seven millions of undistilled tar. Its accumulation in any reasonable quantity will, therefore, take place only in a plant arranged for continuous fractionation.

It was my first intention to compare its density with that of ordinary mercury, and if any appreciable difference was detected to submit it to analysis by the mass-spectrograph, but a favourable opportunity having occurred, I have been able to perform the latter operation under advantageous conditions. The discharge bulb was washed with carbon dioxide until all trace of the spectrum of mercury had disappeared. A portion of the sample was then introduced. This operation was more troublesome than I expected; but ultimately the bulb was flooded with the vapour and a number of mass-spectra were obtained, while the mercury spectrum was predominant in the discharge. On these the groups of isotopic lines were absolutely indistinguishable, both in position and intensity relations, from those of ordinary mercury described in NATURE, Aug. 8, 1925.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, Mar. 10.

The Passage of α -Rays and β -Rays through Matter.

THE loss of energy suffered by a fast-moving electrified particle passing through matter, and the ionisation produced by the moving particle, are phenomena which have, so far, not received accurate quantitative explanation. There are two main theories of the stopping-power due respectively to Bohr (*Phil. Mag.*, 25, 10; 1913; and 30, 581; 1915) and Henderson (*Phil. Mag.*, 44, 680; 1922). The theory of the primary ionisation due to a fast-moving particle is as it was left by Thomson in 1912 (*Phil. Mag.*, 23, 449). In all these theories, classical mechanics is used to calculate the possible energy transfers during encounters between the moving particle and the atomic electrons, and Fowler (*Camb. Phil. Soc.*, 21, 521; 1923) has suggested that the discrepancy which exists between theory and experiment may be due to the inaccuracy of classical mechanics in this field. Whether this is so or not, it may be of interest that a fair proportion of the discrepancy between classical calculations and experimental results disappears when the motion of the atomic electrons is allowed for. The effect of this motion may be considerable, though the velocity of the electron be small compared with that of the moving electrified particle.

The momentum imparted to an electron by a fast-moving electrified particle is to a first approximation independent of the initial motion of the electron, and it is the same as that communicated to an initially

stationary electron provided the shortest distance between the undisturbed paths of the electron and moving particle is the same in both cases. If ϵ represent the kinetic energy of the electron in its orbit and Q_0 the energy given to an initially stationary electron, then, adding momenta, we find that the energy, Q , acquired by an electron is given by

$$Q = Q_0 + 2\sqrt{Q_0\epsilon} \cos \phi, \quad (1)$$

where ϕ is a random angle. It would appear that as the value of Q averaged for all ϕ is Q_0 , it is unnecessary to take the second term on the right-hand side into account. However, in Henderson's theory of the stopping-power and Thomson's theory of ionisation, it is not legitimate to average for all ϕ , only those values of ϕ for which Q is greater than a certain minimum value being concerned. (In Bohr's theory there is no such minimum and it is legitimate to neglect the motion of the atomic electrons.) It follows from (1) and the classical expression for Q_0 that in an element dx of its path the average number, dA , of encounters in which the moving particle gives to the electron energy between Q and $Q+dQ$ is given by

$$dA = \frac{2\pi N E^2 e^2}{m v^2} \frac{dQ}{Q^2} \left(1 + \frac{4}{3} \frac{\epsilon}{Q}\right) dx, \quad (2)$$

usual notation being used. This expression is greater by the factor $1 + \frac{4}{3} \frac{\epsilon}{Q}$ than the expression for stationary electrons. By integration we find that the primary ionisation is given by

$$I = I_P = \frac{2\pi N E^2 e^2}{m v^2} \sum_{s=1}^n \frac{1}{V_s} \left(1 + \frac{2}{3} \frac{\epsilon_s}{V_s}\right) = k \sum_{s=1}^n \frac{1 + \frac{2}{3} \frac{\epsilon_s}{V_s}}{V_s}, \quad (3)$$

N being the number of molecules per unit volume, n the number of electrons per molecule, V_s the binding energy of the s th electron, and ϵ_s its average kinetic energy. (Quantities of the order of u^2/v^2 where u is the initial velocity of the electron and v the velocity of the moving particle are neglected, and this represents the accuracy of the results.) According to Thomson's theory

$$I = I_T = k \sum_{s=1}^n \frac{1}{V_s}. \quad (4)$$

The difference lies in the extra term $\frac{2}{3} \frac{\epsilon}{V}$ in the numerator of (3). ϵ/V is generally equal to or greater than unity, so that the new value is at least about 70 per cent. greater than the old value. C. T. R. Wilson (*Proc. Roy. Soc.*, 104, 192; 1923) found that the primary ionisation produced by β -rays in air was about double Thomson's theoretical value. The value given by (3) is thus nearer the experimental value than the value given by (4), although the uncertainty of atomic data prevents a final comparison. The data for hydrogen is more certain, and certain experimental results obtained by the writer for this case are in satisfactory agreement with the new result. The new theoretical value in fact agrees to within about 5 per cent. with the observed value of the primary ionisation in hydrogen, whilst the theoretical value according to Thomson's theory represents little more than half the observed ionisation.

If R represents the first resonance potential of an electron, then Fowler (*loc. cit.*) has shown that the stopping-power according to Henderson's theory is approximately given by

$$S_F = \frac{2\pi N E^2 e^2}{m v^2} \sum_{s=1}^n \log Q_m/R_s, \quad (5)$$

Q_m being the energy given to a stationary electron

in an end-on collision. According to the present calculations, in which the motion of the electron is allowed for, the stopping-power is given by

$$Sp = \frac{2\pi N E^2 e^2}{mv^2} \cdot \{\log Q_m/R_s + 4\epsilon_s/3R_s\}, \quad (6)$$

the correction being equivalent to decreasing R by a factor of $e^4/3R$. Fowler has shown for α -rays and Wilson for β -rays that the expression (5) is appreciably less than the observed stopping-powers. The curves in the accompanying figure show to what extent the corrected formula agrees with observations in the case of oxygen.

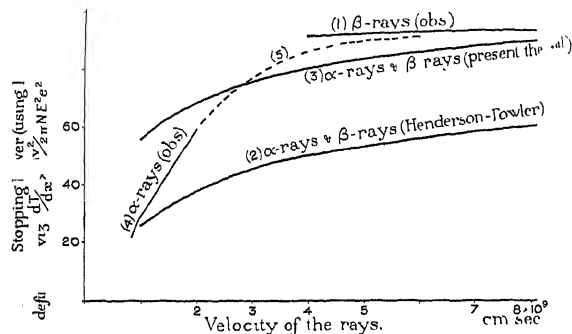


FIG. 1.

Curve (1) represents observed values of the atomic stopping-power for β -rays in oxygen, obtained recently by J. M. Nuttall and the writer (*Phil. Mag.*, 2, 1109; 1926); curve (2) stopping-powers calculated by the Henderson-Fowler formula; curve (3) stopping-powers calculated by the formula proposed here. In curve (4) the observed stopping-powers for α -rays are plotted. To avoid having too many curves the value of Q_m for β -rays is taken equal to the value for α -rays having the same velocity, and a corresponding reduction of the observed values for β -rays is made (involving a change of about 15 per cent.). After making this reduction the theoretical curves for α -rays and for β -rays coincide.

Although the data used in calculating Sp and Sp' is rather uncertain, there can be no doubt that the corrected formula (5) shows a better agreement with observation than formula (4).

It is to be expected that the theoretical formulae for stopping-power should fail at small velocities because it has been assumed that the 'times of collision' for all 'effective' collisions are small compared with the period of revolution of the electron in its orbit. If this condition is not satisfied, there is an *extra restriction* imposed upon the transfer of energy to the atomic electrons, and the stopping-power represented by curve (3) is consequently too high at the lower velocities. This effect probably accounts for the fact that the observed α -ray curve is below curve (3), and also for the comparatively rapid variation of the stopping-power for α -rays with velocity. The relative effect of this new restriction would be expected to be somewhat greater for α -rays than for β -rays with the same velocity. On this view the observed α -ray curve at higher velocities should approach asymptotically the observed β -ray curve, as is indicated by the broken curve (5). It would be interesting to know the stopping-power for α -rays faster than those from radium-C to see if this is the case.

E. J. WILLIAMS.

The University,
Manchester, Feb. 24.

No. 2996, VOL. 119]

Coup-de-Poing.

Of that famous palaeolithic implement which the French call a 'coup-de-poing,' the function is still unknown and disputed; it was once called a 'celt,' and is still regarded by some experts as the head of a once hafted ax; others, like the late M. Comont, have argued that it was used as a scraper; and still others maintain that it is an ax without a helve.

In order not to do violence to the feelings of some of our friends by forcing upon them a name which expresses a view from which they differ, I have suggested, as non-committal and non-combative, the use of a proper name; thus following the example of physicists, who speak of a watt or a volt.

The name I proposed is that of the famous Frenchman, who did such splendid service with the 'coup-de-poing' in his fight over the antiquity of man. I allude, of course, to Jacques Boucher de Crèvecœur de Perthes. From this full title I chose his family name of Boucher. This is not a Christian name, as my friend Mr. Balfour supposes, and my authority for saying this is our distinguished colleague, the Foch professor of French.

A second objection raised by Mr. Balfour in his interesting review (*NATURE*, Feb. 12, p. 226), is that Mr. Neville Jones has misapplied the name. I do not think he has; but this is nothing to the point, for he distinctly asserts that he uses the word 'boucher' as equivalent to the French 'coup-de-poing.'

Admiring as I do the consistent courtesy of Mr. Balfour, which is not confined to his friends, I feel sure he will not wish to introduce into our nomenclature a term like 'hand-ax,' which is eminently controversial and has not even the advantage of elegance. Who would speak of a knife-blade without a handle as a 'hand-knife'?

W. J. SOLLAS.

University College, Oxford,
Feb. 23.

I AM glad that Prof. Sollas has commented upon a remark of mine in my review of Mr. Neville Jones's book, as it gives me an opportunity of correcting an error of my own. When I referred to Prof. Sollas's "Ancient Hunters," in order to ascertain his original application of the term *boucher*, I read the passage (p. 112) as indicating that he wished to apply it to implements "made by striking off with a single blow a thick flake from a larger block of stone, and dressing the side opposite the surface of fracture by several blows directed more or less parallel to its length." I have again read the passage and realise that his intention was to suggest *boucher* as equivalent to the French *coup-de-poing*. I was misled through not having read the passage on the succeeding page, and I assumed that "it" in the sentence "In English it has no name," referred to the type described as above quoted. My reading of the paragraph was also partly influenced by the author having drawn a decided parallel between the Tasmanian implement-type, to which he had just referred, and the so-called *coup-de-poing* series. I apologise for having misinterpreted his intention.

At the same time, I cannot admit that the Tasmanian type—a typical *flake*-implement—is to be regarded as the "homologue, or rather analogue," of the *coup-de-poing*—an equally typical *core*-implement. The technique employed in making the two types is essentially different, and the resultant edges differ in character and, doubtless, in application. But, even if *boucher* is offered as a term to take the place of *coup-de-poing*, I cavil at its adoption, since it is made to cover such a variety of distinct implement-types, ranging from the Chellean pick-like tools with

rounded butts and pointed 'business' ends, to the specialised ovates of the Upper Acheulian series. It is used, in fact, to denote very dissimilar types of tools, the form and presumable function of which have but little in common. It is true that I feel equally dissatisfied with those widely-adopted terms *coup-de-poing*, *faustkeil* and *hand-axe*, all of which, as commonly used, beg a very debateable question; as I venture to doubt whether those early-palæolithic tools which were equipped with a sharp edge all round their contour, were habitually used unhafted (*vide* Sollas, p. 74). I mention this in order to emphasise how badly we are in need of a revised and reasonably descriptive terminology in prehistoric archæology. My chief reason for protesting against the adoption of the term *boucher* is its vagueness. It is used to embrace such a wide range of distinctive types that it really ceases to have a descriptive value, and is liable to cause confusion.

As to the name itself, I have been fully aware of the complete name of Jacques Boucher de Crèvecœur de Perthes, and that, strictly speaking, Boucher is not the Christian name; but the abbreviated name-formula, Boucher de Perthes, under which he is universally, and by most people exclusively, known, suggests 'Boucher' as, shall we call it, a *prénom*, and a correlation, albeit erroneous, with such names as John of Gaunt, William of Wykeham, etc., and this opens up a vista of *prénoms* adopted as generic or specific names for types of prehistoric implements. I am far from wishing to discourage homage to that great pioneer, Boucher de Perthes, but I do feel that our great debt to him could be paid more effectively than by requisitioning his name (or, rather, one of his names) for the purpose advocated; since the suggested term *boucher*, by embracing so much, signifies so little.

I greatly regret to find myself even in trivial disagreement with my good friend, Prof. Sollas, and I am merely desirous of expressing an opinion, which, if challenged and debated, may possibly be productive of good, as helping to stimulate the introduction of an adequate terminology in prehistoric archæology.

In regard to the last paragraph in Prof. Sollas's letter, I may say, though I risk his thinking me wholly unregenerate, that I feel no aversion from the use of the term 'hand-axe,' so long as it is confined to blades of axe-like form, the shape of which suggests that they were used unhafted. Nor do I see any objection to applying the term 'hand-knife' to a knife-blade which was not fitted with a handle. Such terms, where appropriately applied, have at least the utilitarian merit of being fairly descriptive, even though they may lack elegance. There is, moreover, precedent in the familiar expressions, 'hand-line,' 'hand-spike,' etc.

HENRY BALFOUR.

Carbon Monoxide Poisoning in the Absence of Hæmoglobin.

MR. J. B. S. HALDANE's interesting letter on the above (NATURE, Mar. 5) reminds me that in 1886 I made experiments on the influence of carbon monoxide, as well as of other gases (carbon dioxide, hydrogen, nitric oxide, nitrous oxide, sulphur dioxide, and hydrogen sulphide), on the vitality of three specific micro-organisms, namely, *Bacillus pyocyaneus*, Finkler's spirillum, and Koch's spirillum of Asiatic cholera. The results were published in the *Proceedings of the Royal Society* (vol. 45, pp. 292-301), but a brief reference to them may not be out of place now, inasmuch as they bear on this matter of the toxicity of gases.

The method of experiment consisted in exposing the several organisms, in the form of gelatin-peptone

plate-cultures, to an atmosphere of the particular gas, a corresponding control-plate of the same culture being simultaneously incubated in atmospheric air. The behaviour of the three microbes in question in respect of carbon monoxide may be gathered from the following experimental results:

BACILLUS PYOCYANEUS.

	Air-plates (after 4 days' incubation).	CO-plates (after 7 days' incubation).
Number of colonies developing from 1 c.c. of culture . .	113,978	0

When the above carbon monoxide plates were further incubated in air, 100,821 colonies made their appearance. Thus the carbon monoxide had had practically no *permanent* toxic effect on the bacilli distributed in the culture which had been exposed for a period of 7 days to the gas.

KOCH'S SPIRILLUM CHOLERÆ ASIATICÆ.

	Air-plates (after 4 days' incubation).	CO-plates (after 7 days' incubation).
Number of colonies developing from 1 c.c. of culture . .	52,020	19,494

On subsequent further incubation of the carbon monoxide plates in air during 4 days, no increase in the number of colonies took place.

FINKLER'S SPIRILLUM.

	Air-plates (after 3 days' incubation).	CO-plates (after 7 days' incubation).
Number of colonies developing from 1 c.c. of culture . .	4574	2

On further incubation of the carbon monoxide plates in air during 4 days, the number of colonies rose to 501.

Thus in both cases, and especially in that of the Finkler spirilla, a large proportion of the individuals had been killed or rendered incapable of multiplication into colonies by exposure to the gas.

It may be of interest to add that plates incubated in atmospheres of nitric oxide, sulphuretted hydrogen, and sulphur dioxide respectively developed no colonies, nor were any developed afterwards on placing the plates in air-chambers. These three micro-organisms are therefore rapidly and permanently poisoned by the gases in question.

Interest, again, attaches to the behaviour of the organisms exposed to nitrous oxide (N_2O). The *B. pyocyaneus* developed no colonies in this gas, but afterwards in air almost as many colonies made their appearance as on the control air-plates. Koch's spirilla, in nitrous oxide, developed nearly one-third of the number of colonies present on the air control-plates, a further but only slight increase taking place on their transference to air. In the case of Finkler's spirilla, in nitrous oxide, the number of colonies was about one-seventh of that on the air-plates, whilst the further colonies which appeared after transference to air brought the total to about one-fifth of the number on the air-control. The effect of nitrous oxide on

these three micro-organisms is thus very similar in character to that exerted by carbon monoxide.

An atmosphere of carbon dioxide, again, prevented the development of any colonies on the plate-cultures of all three organisms, and only in the case of *B. pyocyaneus* did any appear on transference to air, and then only to the extent of about one-twelfth of the number present on the control air-plates.

In reviewing the record of these experiments made forty-one years ago, it is obvious how greatly the investigation could be extended in various directions. Thus, for example, it would be particularly interesting to ascertain the deportment of sub-cultures made from the colonies appearing on plates which had been exposed to the toxic gases. By pursuing such experiments through a succession of generations it might be possible to arrive at 'strains' of the organisms endowed with the capacity to resist the inhibiting action of a particular gas. Again, differences in behaviour towards a given toxic gas might be made a means of discriminating between otherwise similar organisms, and thus adding yet one more to the already overwhelming number of tests employed in bacteriological diagnosis.

PERCY F. FRANKLAND.

Loch Awe, Argyll.

The First Public Chemical Laboratory in England.

THE statement (NATURE, Feb. 19, p. 300) that the chemical laboratory opened in 1828 in University College, London, is the oldest public chemical laboratory in Britain can scarcely be accepted without qualification, in view of the fact that the University of Oxford had built a laboratory fitted for chemical studies so early as 1683, and that this remained in use until superseded in 1848 by Dr. Daubeny's new laboratory at Magdalen College.

The use that was made of it was intermittent, and the modern practice of class teaching necessitating the multiplication of sets of apparatus had not been evolved; but still the possibility for a person to witness an experiment, even if he did not wish to make it himself, was there.

In those early days the University of Oxford appears to have done little for chemical studies beyond the initial provision of the laboratory and of "the Alkanor and Great Reverberatory" furnaces, and larger utensils such as the great alembic, barrel and worm, with which it was equipped. Smaller earthen and glass vessels and chemicals appear to have been the private property of the laboratory assistant for the time being, who was permitted to increase a very meagre salary by selling to experimenters chemical preparations "at casic rates" and by taking payment for the performance of experiments himself.

Notwithstanding the non-existence of any special university teachers of chemistry, useful practical instruction had been given in connexion with courses of public lectures in the laboratory at various times during the eighteenth century. The auditors were largely composed of medical students, with a sprinkling of the more intelligent members of the general public, who, like Princess Anne in 1683, entered the laboratory to see experiments "to their great satisfaction"; and some of the more curious-minded of these would doubtless have sought to try the experiments themselves. Dr. John Freind, described as well skilled in practical chemistry, in 1704 began courses of *Praelectiones Chymicae* in the laboratory, which were partly based on experimental work there, and were printed and reprinted for the next twenty years. Richard Frewin was among those

who acted as assistant, and it is not unlikely that there too Dr. John Wall, the inventor of Worcester china, may have learnt his chemical manipulation. George Wingfield has left a written record of the methods of analysis in vogue in 1759, and in 1781 a considerable class of divines is reported to have waded "considerably deep in chemistry." Contemporary notes taken four years later by a pupil of Dr. Martin Wall show the distinctly practical trend of the instruction given, and from 1788 until 1793 the celebrated Dr. Beddoes, later patron to young Humphry Davy, drew to the Ashmolean "the largest classes known in the University since the thirteenth century." It was the period when the work of Sadler, the aeronaut, also helped to popularise chemical experiments in Oxford.

Between 1803 and 1822 the existence of the laboratory made it possible for the first Aldrichian professor of chemistry, Dr. Kidd, to deliver courses of from twenty-six to thirty lectures on the subject of his chair during the winter terms, but owing to the lateness of the hour, 7 P.M., it was unlikely that much work was done in the laboratory by his students. One, at any rate, the poet Shelley, is known to have continued experiments in his untidy rooms in college, while the professor himself worked in the University laboratory at his own researches. Doubtless the dim light of the few candles, or oil lamps, which would have been the only source of illumination then available, as well as the grime of ages on the vaulted ceiling of the laboratory, enhanced that appearance of gloom which has been so often remembered by our visitors during the early years of the nineteenth century, and which was unsuited for the critical operations of analytical chemistry as then practised. But it was not before 1848 that the old laboratory was superseded in Oxford, and the fact remains that for over a hundred and fifty years the Ashmolean had provided England with its first public university laboratory, "the designe of this building being not onlie to advance the studies of true and real philosophy, but also to conduce to the uses of life and the improvement of medicine."

R. T. GUNTHER.

The Old Ashmolean,
Oxford.

The Spinning Electron in Wave Mechanics.

THE new wave mechanics admits the existence in physical phenomena of a variable quantity that satisfies a special differential equation. According to Schrodinger, this function ψ is such that the product $\psi\bar{\psi}$, where $\bar{\psi}$ is the conjugate complex quantity, is the electrical density. On the contrary Bateman (NATURE, 118, 839) has recently shown that, by considering two functions, each of which satisfies the wave equation, it is possible to determine the potentials \mathbf{a} and ϕ of the electromagnetic field. Starting from Bateman's considerations, de Broglie (C.R. 184, 81) has shown that the values calculated with this theory coincide with those of Maxwell's theory if one admits that the frequency of the fundamental functions be very high and that the considered phenomenon be nearly stationary in relation to this frequency. De Broglie, however, has shown that, given the wave-

$$\nabla^2\psi - \frac{1}{c^2} \frac{\partial^2\psi}{\partial t^2} - \frac{4\pi^2}{\lambda^2} \psi = 0,$$

putting in the place of the function ψ the two $\psi_1 = A \cos 2\pi\nu_0 t$, $\psi_2 = B \sin 2\pi\nu_0 t$, and introducing the potentials

$$\alpha_x = \frac{1}{2} \left[\psi_1 \frac{\partial \psi_2}{\partial x} - \psi_2 \frac{\partial \psi_1}{\partial x} \right] \dots \phi = -\frac{1}{2c} \left[\psi_1 \frac{\partial \psi_2}{\partial t} - \psi_2 \frac{\partial \psi_1}{\partial t} \right],$$

the results verify Lorentz's equation

$$\frac{\partial \alpha_x}{\partial x} + \frac{\partial \alpha_y}{\partial y} + \frac{\partial \alpha_z}{\partial z} + \frac{1}{c} \frac{\partial \phi}{\partial t} = 0.$$

We thus obtain for the fields **E** and **H** the expressions

$$\mathbf{E} = -k \text{ grad. } \frac{1}{r} (1 + \cos 4\pi\nu_0 t), \quad \mathbf{H} = 0,$$

that is, the characteristic values of a pole of charge k .

With this new aspect of the theory, though on one hand the two functions ψ_1 and ψ_2 have no longer the properties of ψ and $\bar{\psi}$, on the other there is the advantage of correlating wave mechanics with Maxwell's theory. We may note that, using the above proceeding, it is possible to introduce the spinning electron into this theory. To do so, it should be observed that two quantities ψ_1 and ψ_2 are sufficient, according to Bateman and de Broglie, to produce the electromagnetic field; let us see if it is not better to introduce two four vectors, the components of which would be

$$\begin{aligned} \psi_{1x} &= \frac{A_x}{r} \cos 2\pi\nu_0 t, & \psi_{1t} &= \frac{A_t}{r} \cos 2\pi\nu_0 t, \\ \psi_{2x} &= B_x \sin 2\pi\nu_0 t, & \psi_{2t} &= B_t \sin 2\pi\nu_0 t \quad (l = ct). \end{aligned}$$

By this four vector we form a single four vector U such as

$$U_x = \frac{1}{2} \left[\psi_{1t} \frac{\partial \psi_{2x}}{\partial t} - \psi_{2t} \frac{\partial \psi_{1x}}{\partial t} \right] = \frac{\pi\nu_0}{c} \frac{A_x B_t}{r},$$

or putting

$$U_x = \frac{m_x}{c} = \frac{\pi\nu_0}{c} \frac{A_x B_x}{r}, \quad U_t = \frac{q}{c} = \frac{\pi\nu_0}{c} \frac{A_t B_t}{r},$$

we find that the three special components of the four vector U form a vector \mathbf{m}/r , while the fourth component is q/r .

If we now put

$$\mathbf{a} = \text{curl } \frac{\mathbf{m}}{r}, \quad \phi = \frac{q}{r},$$

it follows easily that

$$\frac{\partial \alpha_x}{\partial x} + \frac{\partial \alpha_y}{\partial y} + \frac{\partial \alpha_z}{\partial z} + \frac{1}{c} \frac{\partial \phi}{\partial t} = 0,$$

and the expressions of the electrical and magnetic fields are

$$\mathbf{E} = -\text{grad. } \phi = -q \text{ grad. } \frac{1}{r},$$

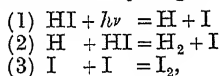
$$\mathbf{H} = \text{curl } \mathbf{a} = \text{curl } \left[\mathbf{m}, \text{ grad. } \frac{1}{r} \right];$$

that is, the field produced by a spinning charge q which is equivalent for the magnetic field to a magnetic dipole \mathbf{m} .

ANTONIO CARRELLI.
Istituto Fisico R. Università,
Napoli, Feb. 6.

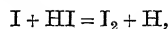
Photochemical Decomposition of Hydrogen Iodide.

THE mechanism proposed by Warburg (*Sitz. der preuss. Akad. der Wiss.*, 300; 1918) for the photochemical decomposition of hydrogen iodide, namely:



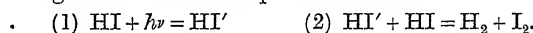
has been generally accepted for a long time but has not received experimental confirmation. Warburg obtained a quantum efficiency of two and showed thermodynamically that reaction (2) was the only secondary reaction possible. Reaction chains cannot

be set up in view of the non-occurrence of the highly endothermic reaction,



which thus interrupts the chain.

Still another interpretation is possible, namely, that discussed by Stern and Volmer (*Z. Wiss. Phot.*, 19, 275; 1920), which leads to the same result of two molecules decomposing for each quantum absorbed. Here an activated molecule in colliding with a normal molecule brings about the decomposition of both.



Until now no observation admits of a decision between these two possibilities, since Warburg worked at rather high pressures.

The writer purposed studying the quantum efficiencies at pressures sufficiently low so that a molecule of hydrogen iodide activated by absorbed radiation cannot make a collision with another molecule before its mean free life, namely, 10^{-7} sec. has terminated or before it decomposes of its own accord. In the former case, if reversion takes place, that is, if collisions are a necessary requisite for decomposition, one should expect the quantum efficiency to be very small, of the order 100 to 200 quanta absorbed per molecule decomposing. In the latter case, if it decomposes in a single act, the quantum efficiency should still remain two as at high pressures. The results are markedly different, and it should be easy to distinguish between these alternatives.

Using the 2080 Å.U. and 2530 Å.U. bands of the condensed zinc spark and working at pressure of hydrogen iodide of the order of 0.1 mm. mercury, well below the critical collision frequency pressure, the writer has found the quantum efficiency to be in the neighbourhood of two. The reaction was studied in its initial stages to avoid secondary absorption by iodine set free. The amount of decomposition was ascertained by freezing out all the hydrogen iodide and iodine, and measuring the hydrogen with a calibrated bifilar quartz manometer described by Coolidge (*J. Am. Chem. Soc.*, 45, 1637; 1923).

Thus Warburg's mechanism is substantiated experimentally. Further, this is the first time it has been proved that a polar molecule may dissociate in a single elementary act, thus affording a possible explanation of the continuous absorption spectrum of hydrogen iodide found recently by Tingey and Gerke (*J. Am. Chem. Soc.*, 48, 1838; 1926), and Bonhoeffer and Steiner (*Z. Phys. Chem.*, 122, 287; 1926).

The work is being continued and a more complete account will be published shortly.

BERNARD LEWIS.
(National Research Fellow.)

School of Chemistry,
University of Minnesota, Feb. 26.

The Tomb of Laplace.

To those interested in the records and memorials of men of science, Paris, no less than London, presents a most attractive field for exploration. The Sorbonne, the Natural History Museum, the Observatory, the schools, the streets, the squares, and the churches abound with statues and monuments, while here and there can be traced the footsteps of such as Pascal, Lavoisier, and Pasteur. No spot, however, recalls such a wealth of historic associations as that of the famous Père Lachaise cemetery, where, to mention only those famed in science, lie Delambre, Arago, Bichat, Cuvier, Charles, Brongniart, St. Hilaire, Comte, Chasles, and a score more. It was here also Laplace was buried, and his funeral discourses were pronounced by Daru, Biot, and Poisson. Over his

grave was erected a marble monument ornamented with a star and bearing the names of his great works.

For sixty-one years Laplace lay here, but in accordance with the express wish of his son, in September 1888 his remains were exhumed and re-interred in the grounds of the family estate at Saint Julien de Mailloc, Calvados. The removal seems to have attracted little attention even in scientific circles, and in view of the interest aroused by the centenary of the death of Laplace the following particulars are perhaps worth recording. For them I am indebted to the Comte de Colbert-Laplace, a great grandson of the famous astronomer, who also informs me that on Dec. 11, 1925, a fire completely destroyed the chateau de Mailloc, and with this were lost all the papers and personal relics of Laplace.

Saint Julien de Mailloc is a small hamlet situated between Lisieux and Orbec, Calvados; and it is on a by-road leading from the main road joining those two places that the tomb of Laplace is to be found. Erected in 1887, it is in the form of a Greek temple about fifteen metres high. The inscriptions recall the birth and death of Laplace, his "Mécanique Céleste," "Système du Monde," and "Théorie Analytique des Probabilités." In a bronze urn in the interior is the heart of Laplace, while the tomb also shelters the remains of his wife, his son, his daughter, and other descendants. Laplace's son, Charles-Emile-Pierre Joseph, Marquis de Laplace, who became a general of artillery, died at the age of eighty-four in 1874, but it was he who desired that Laplace should be brought to Calvados. At the time of the reinterment, the monument which had stood for sixty years in the Père Lachaise, was given to the commune of Beaumont-en-Auge, where Laplace was born, and was re-erected in the cemetery there.

In view of the complete destruction of the papers of Laplace in 1925, it may not be out of place to recall that in NATURE of June 8, 1871, p. 108, is a note to the effect that housebreakers raided Laplace's old chateau at Arceuil and threw the manuscript of the "Mécanique Céleste" into the River Bièvre, from which, however, it was rescued.

EDGAR C. SMITH.

Science Museum,
South Kensington, S.W.7.

Tetragonal Structure of Carbon Steel.

It has been shown by Westgren, Vewer, and many others that the martensite of carbon steel has only the crystal structure of α iron, and sometimes has simultaneous structures of α and γ iron with carbon in the state of solid solution. Recently Fink and Campbell (*Transactions of the American Society of Steel Treating*, 9, 717; 1926) found the body-centred tetragonal structure with a ratio of axes 1.06 in carbon steel (1.5 per cent. carbon) after quenching in water from 940° C. Our investigations of carbon steel quenching in water show also the body-centred tetragonal structure. The following table gives the carbon content, the temperature of quenching T , the ratio of axes $c = a/b$, and their dimensions a and b :

Per cent.	T , °C.	c .	a , 10^8 cm.	b , 10^8 cm.
0.8	1100	1.027	2.851	2.920
1.0	1100	1.051	2.843	2.987
1.2	1000	1.058	2.848	3.010

In the samples of steel having 0.8 and 1 per cent. carbon in addition to the tetragonal structure were found γ iron (in the sample of steel which had 1 per cent. carbon there was no α iron).

From the above table we arrive at the conclusion that the observed tetragonal structure of steel is a solid solution of carbon in the body-centred tetragonal lattice of metal atoms. It is probable that the martensite has always a body-centred tetragonal structure (simultaneously there could be α and γ iron).

N. SELJAKOW.
J. KURDUMOFF.

Physico-technical Laboratory,
Leningrad, Sosnowka 2.

The Metallurgical Laboratory of
"Krasnii Putilovetz,"
Leningrad,
Feb. 9.

Early British Patent Grants.

THE contributor of the "Calendar of Discovery and Invention" appearing in the pages of NATURE has in the issue for Feb. 26 fallen into a not uncommon error, when he records Mar. 2, 1617, as the date of the first British patent for invention. This certainly is not the case. The reasons that caused the then Commissioners of Patents to start the famous official series of English patents with the year 1617 were purely fortuitous, and in no way endow this particular patent with any special claim to immortality. The researches of Mr. Hulme and others have brought to light a large number of earlier grants, mostly by Elizabeth and James I., but including one (that to John of Utynam for the making of coloured glass) so early as 1449, and it is to this one that the distinction of priority must for the moment be given.

Moreover, the Statute of Monopolies cannot be correctly described as for the first time securing "the sole working or making of any manner of new manufacture within this realm to the true and first inventor." The Statute was passed simply to prevent the Crown making vexatious monopoly grants; it initiated nothing, and expressly exempted from its operation the use of the existing prerogative in respect of new inventions, a prerogative which, as we have seen, had been constantly exercised for many years past.

ALLAN GOMME.
(Librarian.)

The Patent Office Library,
25 Southampton Buildings,
London, W.C.2.

Prehistoric Archaeology in Yorkshire.

IN NATURE of Mar. 5, p. 364, announcement is made of the proposed formation of an 'out door' museum at Easington, Yorks, by the East Riding Antiquarian Society. The exhibition of 'obsolete farming appliances' is no doubt a praiseworthy object; but one is tempted to inquire when the Mortimer collection is to become accessible for study by those interested in prehistoric archaeology? This collection represents the life's work of the late J. R. Mortimer, who excavated a very large number of barrows on the Yorkshire wolds. It ranks with similar collections at Devizes and in the British Museum; but it has not even been seen by most of the present generation of archaeologists, including the present writer. The collection is of national importance, and if the people of Yorkshire do not appreciate their good fortune in possessing it, they should hand it over to others who do. A collection in packing-cases is of no use to any one.

O. G. S. CRAWFORD.
Ordnance Survey Office,
Southampton, Mar. 10.

The Centenary of the Friction Match.

By Prof. WILLIAM A. BONE, F.R.S.

EXACTLY a hundred years ago next Thursday, John Walker, pharmacist of Stockton-on-Tees, recorded in his Day-Book the first credit sale of his newly-invented 'Friction Lights,' which were indisputably the first practical and useful friction matches. This historic record was as follows :

"*Die Saturni Apr. 7th 1827*

No. 30

Mr. Hixon

Sulphurata Hyperoxygenata Frict. 100

Tin Case 2d. 1. 2."

There are few scientific inventions which have been more saving of time and trouble to Mr. Everyman, or more generally used the world over, than that of the humble friction match. It is now so cheap and ubiquitous that to offer a light to a stranger on a railway journey is perhaps the commonest of everyday courtesies amongst all classes of society. No one feels the cost of matches; they are supplied gratis almost everywhere, and the vast number wasted passes unnoticed: truly a 'universal aid,' without which we should be thrown back to the inconveniences of the good old 'flint and tinder' days.

John Walker, to whose memory honour is due to-day, was born at Stockton-on-Tees in 1781 and died there in 1857; my grandfather (the late Thomas Hutchinson, *d.* 1893) knew him well. A memoir published by Dr. R. W. Foss ("*Archæologia Æliana*," vol. 7) says that as a youth he was articled to Mr. Watson Alcock, surgeon of his native town, and that, after completing his apprenticeship, he went to London (doubtless as a student) for a few years, returning to become Mr. Alcock's assistant.

It was during his apprenticeship that John Walker first began to show his scientific proclivities. He was constantly making chemical experiments, attained considerable reputation in the locality as a botanist, and later on took up the study of mineralogy, in which he became very proficient. After his invention of friction matches (or 'friction lights' as he usually called them) had brought him wider fame, as well as the prospect of a fortune, he steadily refused to patent it, being (as Dr. Foss remarked) "a studious, retiring man, caring more to pursue his scientific studies, whether botanising or experimenting in chemistry, than speculating in order to make money."

Although qualified as a surgeon, "an invincible horror to surgical operations," which he never was able to overcome, soon led Walker to abandon that profession, whereupon he spent some years in Durham and York acquiring commercial experience in the employment of wholesale druggists. Eventually, in 1819, at the age of thirty-eight years, he returned to his native town, where he established himself in business as a pharmacist, at No. 59 in the High Street (since 1896 marked by a suitably engraved brass-plate), living in a house on the

Quayside, then a pleasant locality but now much dilapidated. Thirty years later he retired from business, having acquired sufficient for all his needs. He died in 1857 at Stockton-on-Tees, and was buried in the churchyard of the neighbouring parish of Norton-on-Tees, where an unpretentious stone marks his grave.

Walker was never married, but lived with a niece who survived him more than thirty years. He was described by a contemporary as "a trim, dapper, little man," of cheery disposition and ready wit; a man rather particular as to fashion in dress, well known at the time of his invention by his brown tail-coat, drab knee-breeches, grey stockings, white cravat and tall beaver hat.

For many years, how Walker came by his invention was scarcely known. According to an account published in a local newspaper in 1852, it was the result of chance. "Mr. Walker was preparing some lighting mixture for his own use when a match, after being dipped in the preparation, took fire by accidental friction on the hearth . . . and the hint was not lost." Also, Dr. Foss said, "On one occasion . . . some chemical mixture he had compounded fell upon the hearthstone and ignited . . ."; moreover, that Walker did not divulge the exact chemical composition of his matches, and that "from a careful search which has been made in his books it has not been possible to find it. . . ." Such, then, was the local tradition more than fifty years ago.

About the year 1890, however, an old Day-Book in Walker's own handwriting was found among a heap of other papers relating to his pharmaceutical business, which gave a new clue as to how he made the invention. This Day-Book covered the period from Aug. 9, 1825, to Sept. 22, 1829, inclusive, during which time the invention was made. It was handed over to me for investigation (1896) together with eight matches, which undoubtedly had been purchased of Walker himself sometime not later than November 1827. I copied all the relevant entries from the book, and made an analysis of the tip of one of the matches, which confirmed a then current belief that he had used a mixture of potassium chlorate and antimony sulphide made into a paste with gum and starch.

The Day-Book also revealed that, so early as 1825, Walker had been selling a mixture of equal parts of potassium chlorate and antimony sulphide to three different persons, but chiefly to a Mr. Vollum, Junr., of Hartlepool. Entries of such sales continued until Dec. 6, 1828, quite independently of those of his 'friction lights,' the first being as follows :

"*Die Saturni Nov. 19 1825*

Mr. Walton Jr. Norton

by Potassa Chlorat. 3 j Ant. sul. nigri 3 j

Muc. g. i. Aqua q. s. ft. pasta

N.B. Excellent. 1. 6."

The "N.B. Excellent" suggests that the com-

position in question had been made up *experimentally* for some purpose, which had been well answered. There is also strong evidence in the Day-Book that the purpose was percussion powder, because (1), there are six entries during the years 1826-8 of the Mr. Vollum in question purchasing a composition described either as "pulv. percuss." or as a mixture of equal parts of antimony sulphide and potassium chlorate, the name of Vollum not occurring in any other connexion; and (2), all these six entries, as well as the only two others relating to the purchase of such material during the years covered by the book, were in the autumn or early winter months (September to January), when game-shooting is practised, no such entry ever having been made during any other time of year.

Two entries in the book (dated July 26, 1827, and Sept. 12, 1828, respectively) refer to sales to a Mrs. Faber of "*oxygent^d. matches*" tipped (as is recorded) with chlorate of potash and sugar only. Undoubtedly these refer to the 'oxymuriate or dipping matches' (strips of wood tipped with a mixture of chlorate of potash, sugar and gum, and ignited by contact with strong sulphuric acid) invented by Chancel in 1805, which had been fairly widely used since 1812.

Therefore it seems reasonable to suppose (1), that Walker had occasionally made Chancel's 'oxymuriate matches' to the order of at least one of his customers; (2), that so early as 1825, if not before, he was experimenting on the production of a sporting 'percussion powder,' composed of equal parts of chlorate of potash and antimony sulphide, for certain other customers, more particularly Vollum; and (3) that, having succeeded, it occurred to him to produce a *friction* match by substituting the same composition for the mixture of potassium chlorate and sugar used for tipping the Chancel *dipping* match. It is important also to observe (4) that he never used the term 'matches' in reference to his own invention, which he usually called 'friction lights' (sometimes, however, 'attrition lights'), and (5), that in the first entry in the book of their sale (*g.v.*), there occur the words "No. 30," probably signifying (as I think) the batch-number of the friction lights in question. If this surmise be correct, he probably had been making them for some time prior to the first recorded sale, which (be it noted) was a credit, and not a cash, transaction.

Walker's 'friction lights' were thin splints of wood, three inches long, one-sixth inch broad, and one-twentieth inch thick, tipped with the aforesaid composition of equal parts of antimony sulphide and potassium chlorate, as my analysis has shown. They were sold by him at 100 for a shilling, in a cylindrical tin case, for which he charged an extra twopence (or a shilling for 84 lights *plus* case). With each case was supplied a piece of 'glass-paper,' folded in two, and a 'light' was ignited by pinching its head between the folds, and then suddenly withdrawing it.

In the Day-Book are entered 23 credit sales of friction lights during 1827, 76 during 1828, and 69 during 1829, or 168 altogether. By the year

1829 their fame had reached London; it is said that Faraday had exhibited some of them at a lecture in London "which set the scientific world thinking."

In that year, also, the following notice of them appeared in the *Quarterly Journal of Science, Literature, and Art*, under the title of "Instantaneous Light Apparatus." "Amongst the different methods invented in latter times for obtaining a light instantly ought certainly to be recorded that of Mr. Walker, chemist, Stockton-on-Tees. He supplies the purchaser with prepared matches, which are put up in tin boxes, but are not liable to change in the atmosphere, and also with a piece of fine glass-paper folded in two. Even a strong blow will not inflame the matches, because of the softness of the wood underneath, nor does rubbing upon wood or any common substance produce any effect except that of spoiling the match; but when one is pinched between the folds of the glass-paper, and suddenly drawn out, it is instantly inflamed. . . ." From 1829-30 onwards, Samuel Jones, of 201 Strand, London, made and sold imitations of them as 'lucifers' (a name which Walker always repudiated), saying that they had been "lectured on at the London and Royal Institutions." It is said that Walker, who was always very modest about his invention, even to the extent of thinking it unimportant, did not long afterwards continue to make 'friction lights.'

Such, then, were the nature and circumstances of this most useful invention. Before many years had passed, other claimants to it arose. At one time the late Sir Isaac Holden thought himself to be the original inventor of 'friction matches,' but in a letter which he wrote to the late Mr. Joseph Parrott of Stockton-on-Tees on Feb. 3, 1894 (*after* hearing of the discovery of Walker's Day-Book), of which I have a photograph, he said, "My invention, if so it may be called, was introduced by me in Oct. 1829 in *entire ignorance* of Mr. Walker's." Unfortunately, the Report of Juries of the Exhibition of 1851 contained a judgment by Warren de la Rue and A. W. Hofmann that "The first friction matches or congreves made their appearance about 1832," without even mentioning Walker's prior invention. Now the 'congreves,' which were introduced into England from Germany and Austria in that year, were originally invented by a young French chemist, Charles Sauria of St. Lothair (*d.* 1895), who in January 1831 (or nearly four years after Walker's invention), whilst a student at the Collège d'Arc, Dole (Jura), made friction matches containing phosphorus, but (like Walker) he did not patent his invention, which some think was pirated in Germany. In 1884 the French Government recognised Sauria's 'l'Invention des Allumettes Chimiques' by appropriately granting him a 'bureau de tabac'; and a medal was also bestowed upon him by the Académie Nationale Agricole. Unfortunately, except that in 1913 *Punch* published some verses in his honour, so far nothing has yet been done in Great Britain to recognise or commemorate John Walker's invention; but its centenary affords the opportunity of removing this reproach.

Activities of the Medical Research Council.

PERUSAL of the report of the Medical Research Council for 1925-1926,¹ as usual, gives the reader a bird's-eye view of much of the research work which has been carried out in Great Britain on medical and allied subjects during this period. By the system of grants-in-aid to workers in university and hospital laboratories, etc., the Council is enabled to promote research on a much wider variety of subjects than would otherwise be possible; in fact, almost two-thirds of the Parliamentary grant of £135,000 was utilised in this manner, the greater part of the remainder being devoted to the expenses of the National Institute at Hampstead and of the farm laboratories at Mill Hill. Only a few of the more salient points of the report can be touched on in this short account.

Before referring to the scientific work, attention may be directed to certain events of the year which affected the Council. By an Order in Council in July the constitution of the Committee of the Privy Council for Medical Research was altered and the Committee now consists of the Lord President of the Council, the Secretaries of State for Home and Dominion Affairs, for the Colonies, and for Scotland, and the Minister of Health. A few months previously an alteration of the charter of the Medical Research Council had been approved; the amendments provided, *inter alia*, for an increase in the numbers of the Council from ten to eleven, of whom eight are appointed in respect of their scientific attainments, whilst the remaining three include a representative from each of the Houses of Parliament. Two of the former retire each year and are not eligible for immediate reappointment, whilst one of the latter group retires every two years but is eligible for immediate reappointment.

During the year also, the Committee of Civil Research was set up to provide for the discussion of problems which are common to more than one field of science, or to more than one part of the Empire. In addition, representatives of the Medical Research Council were appointed members of the Research Special Sub-Committee of the Imperial Conference and took part in the deliberations of this Committee.

PHYSIOLOGICAL AND BIOCHEMICAL INVESTIGATIONS.

Insulin.—Since the original discovery of insulin by Banting and Best, the problem of the fate of the sugar which disappears under its action from the blood has led to much speculation and stimulated numerous researches, without reaching a final solution until last year. It was known that in the diabetic organism, insulin produced a storage of glycogen in the liver, but in the normal animal the disappearance of sugar from the blood was usually accompanied also by a decrease in the glycogen of this organ; at the same time, examination of the respiratory exchange had shown

that, although the metabolism became predominantly carbohydrate in type, yet the oxygen consumption was not sufficiently increased—it might even be decreased—to account for the combustion of all the sugar vanishing. A brilliant series of researches at the National Institute during the past year appears now to have solved this problem.

C. H. Best, in a preliminary investigation on artificially perfused limbs, was able to show that the skeletal muscles were the chief site of the disappearance of sugar. Working with J. P. Hoet and H. P. Marks, he then found that a large part of the glucose disappearing could be found as glycogen in the muscles; although the inorganic phosphate of the blood falls together with the sugar, no storage of phosphoric esters in the muscles was observed. Finally, Best, Dale, Hoet and Marks made a complete balance-sheet of the glucose exchange under the action of insulin. Under all conditions of glucose supply in relation to the dose of insulin, the total amount of glucose disappearing from the system—the decapitated eviscerated preparation—was equal to that burnt, as estimated from the oxygen consumption, together with that found deposited as glycogen in the muscles.

The loss of glycogen from the normal liver under the action of insulin is a secondary effect of the fall in the blood-sugar. In the diabetic with a high blood-sugar, insulin promotes glycogen deposition in the liver, but under its continued action, with a fall in the blood-sugar below a critical level, this glycogen will be transferred, as sugar, to the muscles. The liver glycogen acts as a carbohydrate reservoir, easily available if the blood-sugar falls; muscle glycogen, on the other hand, does not appear to have this function. The depression of the total metabolism under the action of insulin, mentioned above, is most easily explained on the assumption that insulin restrains the new formation of carbohydrate from protein, or fat (Burn and Marks), in the liver. It may therefore be concluded that the action of insulin is identical in both the normal and the diabetic organism.

A very interesting observation has been made by Hoet and Marks, as an incidental outcome of this work on insulin. It has been known for some time that animals dying from an overdose become rigid almost immediately. This also occurs when a rabbit dies after daily thyroid feeding for some weeks. In both cases there is almost complete exhaustion of the muscle glycogen; the *rigor mortis* sets in also whilst the muscles are still alkaline. It appears that the rigidity is due to a failure to reform the hexose-phosphate or 'lactacidogen,' from a shortage of the raw material, the glycogen. Under ordinary conditions the muscle enters into *rigor* only some time after death, and with an acid reaction; in this case the cause must be sought in the death of the synthetic mechanism.

Histamine.—Since the discovery by Dale, Laidlaw, and Richards that histamine, whilst

¹ Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1925-1926. Pp. 161. (London: H.M. Stationery Office, 1926.) 3s. 6d. net.

stimulating smooth muscle, relaxes the walls of the capillaries, leading to a marked fall of blood pressure, interest in this substance has been maintained, more especially since it was probably responsible for many of the cases of 'shock' seen during the War. More recently it has been suggested that it may have therapeutic applications. It has been known for many years that extracts of most tissues cause a fall in the blood pressure; recently a liver extract has been advocated as a therapeutic measure in high blood pressure in man. Best, Dale, Dudley and Thorpe have succeeded in identifying the active principles of liver extracts and have found them to be histamine and choline. In addition, large amounts of histamine have been extracted from fresh lungs, e.g. 0.3 gm. from 10 kgm. of lung. It must be remembered in connexion with these quantities that 1 part in 250 million parts of water can produce contraction of the smooth muscle of the uterus.

The physiological function of histamine in the body is still a subject for research, but it may be suggested that it plays a part in the chemical control of the capillary circulation, perhaps as an antagonist to adrenaline. This suggestion is supported by the work of Sir Thomas Lewis and his colleagues; they have found that the local reaction of the skin blood-vessels to irritation or injury can be exactly imitated by the injection of minute amounts of histamine.

BACTERIOLOGICAL INVESTIGATIONS.

Cancer.—The work of Gye and Barnard on the filter-passing virus of cancer has been continued. It will be remembered that Gye, working with the Rous chicken sarcoma, found evidence which he believed could only be explained on the hypothesis that the cell-free filtrate from the tumour contained two factors, either of which alone was innocuous. One was a thermolabile substance, specific to the species from which the material was derived; the other was a filter-passing virus, which could be obtained also from mammalian tumours. Gye's recent work has confirmed his original observations; thus he has been able to destroy the virus by using

antiseptics like acriflavine or cyanides, instead of chloroform, leaving the specific factor intact in the solution. Some parts of his work have been confirmed by other investigators, other parts are unconfirmed or the validity of his evidence denied. Only further experiments can settle the conflict of testimony.

Dog Distemper.—P. P. Laidlaw and G. W. Dunkin have continued their investigations into canine distemper; the work is greatly aided by the fund collected by the *Field* newspaper. It is now quite certain that the disease is caused by a filter-passing virus; unfortunately, no means have yet been discovered of cultivating it *in vitro*. It can, however, be transmitted to ferrets and back again to dogs at will. The ferret can be immunised by inoculation with formalin-treated virus and is then usually protected against what is an almost invariably fatal disease in this animal. On the other hand, attempts to immunise dogs have been less successful; but it is hoped that a primary inoculation of dead virus followed by a mild distemper infection while the animal is refractory to the disease, will develop sufficient resistance to protect the animal against chance infections.

Chemotherapeutics.—In conclusion, attention may be briefly turned to one or two chemotherapeutical investigations. S. R. Douglas has shown that sanocrysin (sodium gold thiosulphate) has not a specific action on the tubercle bacillus, but so affects the cells of the tubercular lesions as to give indirect damage to the infecting organisms; in rabbits, S. L. Cummins has found that mild infections can be eliminated by this drug, but heavy or virulent infections cannot be cured. In another direction Dobell and Laidlaw, utilising their method of cultivating *entamoebæ in vitro*, on media containing solid rice-starch, have shown that emetine and cephaeline are specifically poisonous to *E. histolytica*, the causal organism of amoebic dysentery in man. Minute quantities inhibit its growth and ultimately destroy it, but relatively strong concentrations are necessary to kill it at once. The importance of this time factor in the treatment of the human disease is obvious.

Obituary.

DR. A. W. CROSSLEY, C.M.G., C.B.E., F.R.S.

DR. ARTHUR WILLIAM CROSSLEY, who died at his residence, Thorngrove, Alderley Edge, Cheshire, on Saturday, Mar. 5, at the relatively early age of fifty-eight years, was the son of the late Richard Crossley and was born at Accrington on Feb. 25, 1869. His early education was obtained at Mill Hill School, from whence he proceeded to the Owens College, Manchester, then part of the federated Victoria University, where he graduated in the honours school in 1890. It is evident that thus early in his career his tastes inclined towards the organic side of chemistry because, after graduating, he went to Würzburg to work under Emil Fischer, then well on the way towards the zenith of his fame, and from there published his first paper, a short

note on the optical behaviour of dulcitol, in 1892. He graduated Ph.D. at Würzburg in 1892 and then followed Fischer to Berlin, from which University he published his second paper, on the oxidation of mucic acid, in 1894.

In the autumn of 1894, Crossley returned to Manchester to work with the younger Perkin, who had two years previously succeeded Schorlemmer in the chair of organic chemistry and had started the Manchester school of organic research, which was afterwards to become world famous. He was awarded a Bishop Berkeley fellowship, which, however, he relinquished in the following year on his appointment as lecturer in chemistry at St. Thomas's Hospital; nevertheless, during his short stay in Manchester, he completed an important paper on the substituted pimelic acids, which he published

conjointly with Prof. Perkin in 1895. During the time he remained at St. Thomas's Hospital, that is, until 1904, when he was appointed professor of chemistry to the Pharmaceutical Society of Great Britain, he published several papers on the malonic ester condensation, mainly in connexion with the formation of hydro-aromatic compounds. This work was evidently the outcome of that which he had started earlier with Perkin on the constitution of camphor—a problem at that time occupying the full attention of Perkin's school at Manchester. It appears that Crossley completed this camphor work at St. Thomas's, for it is embodied in a paper on dihydrocamphoric acid published with Perkin in 1898, and that, moreover, the peculiar properties of dihydrocamphoric acid decided him to subject a whole series of hydro-aromatic substances to special investigation.

In this way Crossley's life work, so far as organic chemistry is concerned, was determined, and we find a number of papers from his pen appearing at regular intervals from 1896 until 1914, in which year he was appointed Daniell professor of chemistry at King's College (University of London). The insight and manipulative skill shown by these researches place Crossley in the front rank of modern organic chemists and would have enabled him to accomplish far greater achievements had not fate determined otherwise, for the advent of the War directed his energies into other channels of wider and more urgent importance. During his stay at St. Thomas's Hospital he was associated in his research work with Henry Rondel Le Sueur, and while at the Pharmaceutical Society, with Charles Gilling and Nora Renouf, with whom he published many important papers. He was awarded the D.Sc. of the Victoria University in 1899, and was elected fellow of the Royal Society in 1907. He received the Longstaff medal of the Chemical Society in 1918.

Shortly after the outbreak of War, the Royal Society formed a committee to render the Government any assistance that might be necessary on the scientific side, but after the first definite use of gas in April 1915, it was evident that special measures would have to be taken to meet the new menace. On the formation of the Trench Warfare Department under Colonel (now General Sir Louis) Jackson, Crossley was nominated by the Royal Society as a member of the Advisory Committee of the Department and became its first secretary. Early in 1916 it was realised that the trench warfare experimental grounds at Clapham Common and Wembley were too small for the purposes of large-scale experiments, and were, moreover, situated in areas too congested to warrant the use of materials likely to be dangerous to health. Search led to the discovery of a tract of land of poor agricultural value situated between the London Road and the railway about two miles from Porton in Wiltshire, and here, in the spring of 1916, it was decided to establish an experimental station for investigations in connexion with chemical warfare.

The problems requiring solution were urgent and

complex, the power and safety of our armies in the field depending upon the provision of offensive and defensive appliances in the shortest possible time. Nothing existed on the ground but a few farm buildings and out-houses, and everything from a gun range to a drainage system had to be provided as quickly as possible. Crossley undertook to put things in order, and for this purpose he was given the rank of Lieutenant-Colonel R.E. Here, then, with a band of devoted helpers, he started to carry through what was in all probability the most difficult task of his life, requiring as it did the exercise of infinite tact and a power of control over men such as few, especially those trained in academic surroundings, possess. It was, indeed, a prospect which the boldest might have hesitated to face. Nevertheless, Crossley played his part as a soldier with all the energy and force with which he did everything else, and brought to bear a personal charm of manner which enabled him, although a strict disciplinarian, to endear himself to all the officers and civilians serving under him. It was due to him and those with him that within a comparatively short space of time the experimental station at Porton became a real factor in the War, and that it was established on a basis which not only caused it to be the centre of chemical warfare research in Great Britain, but also enabled it to serve as a model on which similar organisations have been built in other countries.

It was the present writer's lot to form one of the group of five who walked from the London Road into that peaceful valley one Sunday in February 1916, and also to be one of those who was present when His Majesty the King visited the station in 1918. No one who has not undergone these two experiences can realise the change Crossley had wrought in the time. For some considerable period he acted as liaison officer with the French and he visited the front on many occasions. His work also necessitated frequent consultations with the chemical advisers to the armies, and for this purpose he made many visits to St. Omer and Paris Plage. Later, the increase of work at Porton required his full attention and he delegated his French work to others. For his services to the French Government he was created an *Officier de la Légion d'Honneur* on the occasion of the visit of the Chemical Warfare Advisory Committee, which had now become part of the Ministry of Munitions, to Paris. He was created C.M.G. in 1917, and C.B.E. in 1919.

During the War the Department of Scientific and Industrial Research, which had been established as a Committee of the Privy Council in 1915, decided to form industrial research associations in order that, after the War, there might be an organised effort, backed by the latest scientific methods, to meet the competition which would then arise. Among those, one of the latest to be formed was that constituted in 1919, dealing with the cotton industry, for which, in the following year, the house at Didsbury, Manchester, afterwards known as the Shirley Institute, was acquired. Crossley was appointed first Director of

the Association, and here, as at Porton, he was faced with the problem of creating an organisation from the beginning. The Shirley Institute comprised a large private house situated in its own grounds but bearing no semblance to a scientific institution. He had to undertake the difficult task of installing laboratories and equipment which could deal effectively with the problems arising in this basic industry. Such problems would necessarily cover a wide field, including many branches of science, and would, therefore, entail the initiation and control of researches in subjects other than chemistry. He had not only to help the industry by research on scientific lines, but also had to accomplish the still more delicate task of appealing by the work of the Institute to those who were anxious for immediate practical results and were not always cognisant of the essential need for fundamental research as a foundation for industrial progress. It is a remarkable fact that in two years, that is to say, in approximately the same time as was taken to organise Porton, the Shirley Institute was established as a fully equipped research unit and was formally opened by the Duke of York in 1922. Since then the volume of research work from the Institute has not only made it a model research association, but has also, by reason of the practical application of its work, convinced many who were previously sceptical of the value of fundamental research in relation to the industry.

Despite his many other activities, Crossley found time to devote himself to other public work, and was from 1903 until 1913 secretary of the Chemical Society and from 1913 until 1925 its foreign secretary. In the latter year he was president of the Society, but had to relinquish the office after one year owing to failing health. He was a man, therefore, who gave great and useful service to his country, and received the recognition of his King, his University, and his fellow scientific workers. Had he lived he would have attained to greater honours, for the full power of his work will not be realised until the lapse of time has proved its value. Without question his life was shortened by his devotion to public duty and by the strain imposed on his constitution by the high sense of responsibility he felt in all the work he undertook. The War years imposed a heavy burden, which, although cheerfully borne, nevertheless left its mark on a not too robust constitution, and he never seemed quite the same man afterwards. He was essentially a pioneer, for his great activity of mind led him to seek new problems as soon as he had settled the one in hand to his own satisfaction and had brought it to a stage at which he felt he could safely hand it over to others. He was denied, therefore, the complacent rest which ought to follow the contemplation of smoothly running administrative machinery well and truly constructed. J. F. T.

M. F. E. TURPIN.

M. FRANÇOIS EUGÈNE TURPIN, well known as the inventor of melinite, one of the high explosives used in shell-filling, died on Jan. 24 at Pontoise.

We are indebted to a recent issue of *La Nature* for the following particulars of his life. After his birth at Rosendael in 1849 his parents moved to Paris, where, on leaving school, he began to study medicine. But he became interested in chemical research, and it was not long before his natural skill in experimental work was publicly recognised by the bestowal upon him by the Paris Academy of Sciences of the Montyon prize for his invention of harmless colouring matters for children's toys. This invention presently involved him in some litigation, but, nothing daunted, he applied himself with energy to the study of explosives. Those were the days of black gunpowder, dynamite, and gun-cotton. The instability of nitrated organic compounds had rendered them unfit for use by the artillery and even unsafe to store in magazines. With the object of overcoming these difficulties Turpin decided to abandon the search for suitable material among aliphatic compounds and turned his attention to those of the aromatic series. After seven years of ceaseless toil he perfected a process for preparing a suitable high explosive from picric acid by the simple device of melting it in an oil-bath and running it into moulds. When, shortly afterwards, a suitable detonator had been devised for use with the new explosive, the French Government purchased the new process from him; but the secret appears to have been treacherously revealed to a British firm by an artillery officer, whom Turpin vigorously denounced in a volume entitled "*Comment on a vendu la mclinite.*" For this indiscretion Turpin was prosecuted, and eventually condemned to prison on the charge of having revealed in his book secrets of importance to the national defence. After spending nearly two years in prison he was pardoned in 1893, and in 1901 he was completely restored to favour by being elected to serve as a technical adviser to the artillery. In this capacity he rendered invaluable service to France until after the War, when the State awarded him an annuity.

PROF. CARL GRAEBE, who died after a long illness on Jan. 19 in his native town, Frankfort, within a few weeks of completing his eighty-sixth year, had for many years occupied with distinction the chair of chemistry at Geneva. Gracbe's reputation was made by his brilliant researches on the constitution of aromatic and heterocyclic compounds, particularly on quinones, phthalic acid, alizarin, and acridine. He also succeeded in demonstrating the constitution of anthracene, phenanthrene, fluorene, carbazol, etc., and was a pioneer in the investigation of the relationship between colour and chemical constitution. Having shown that alizarin was derived not from naphthalene but from anthracene, the synthesis of that important dyestuff could not be long delayed, and the solution of this problem in 1868 by Gracbe and Liebermann marks an important stage in the development of the dyestuff industry. Gracbe was also the author of a work on the history of organic chemistry.

News and Views.

THERE is now real ground for hope that a new measure for the protection of wild birds in Great Britain may reach the Statute Book within the next few months and so come into force on Jan. 1, 1928. The Wild Birds Protection Bill received a second reading in the House of Commons on Mar. 25, and is referred to a standing committee. Ever since the Departmental Committee on the subject reported in 1919, legislation on these lines has been pending. Several bills, not greatly differing from the present one, have been introduced, and have made progress in varying degree: they have eventually failed not through opposition but merely on account of the exigencies of parliamentary time. On this occasion the crucial stage has been survived, and if the Bill is given sympathetic treatment in committee, there should be no difficulty in its receiving a third reading and then passing through the House of Lords.

WE published a full account of an earlier form of the measure two years ago (*NATURE*, June 20, 1925, p. 934), and a brief indication of the scope of the present Bill will here suffice. Some general protection is given to all birds by the prohibition of destruction and capture by certain methods and at certain times and places. Special protection, further, is given to different species according to the categories in which they are classified for the purpose. Birds in Category I. and their nests and eggs are protected at all times. Birds in Category II., with their nests and eggs, are protected during the close season, normally Mar. 1–July 31. Birds in Category III., but not their nests or eggs, are protected during the close season except against the owner or occupier of the land or his agents. Named as coming within the first category are the greater rarities, some much persecuted species, and a few others: in the second are birds which especially need protection in the breeding season. The third category comprises all birds not scheduled as belonging to the first or second. The Bill will supersede the existing legislation on the subject. Its great merits are its simplicity, the uniformity which it will introduce, and the better powers given for enforcement. These should lead to a much greater effectiveness in practice.

IT is noteworthy, from the report of the debate on the second reading of the Protection of Wild Birds Bill, that such opposition as there was, apart from points of detail which will be raised again in committee, mainly arose not from objection to the proposed provisions but from a desire for a still wider measure. The protection of all birds at all times, apart from such few species as might have to be blacklisted, was indeed suggested. The Bill as it stands, however, seems to achieve a wise moderation. It gives absolute protection where it is most needed, and some measure of protection to all birds: it avoids the unnecessary creation of new offences, and the imposition of excessive restrictions which would tend to alienate that public opinion upon which the successful working of a law of this kind must largely depend.

AMONG the great City Companies of London there is none more closely associated with pure and applied science than the Goldsmith's Company, which this week is celebrating the six-hundredth anniversary of its foundation. By a happy coincidence, the Prime Warden of the Company this year is Sir Dugald Clerk, who presided at the banquet held on Monday, and one of the Wardens is Sir William Pope, who will become Prime Warden the year after next. Other fellows of the Royal Society who have been Prime Wardens of the Company are Mr. George Matthey, Sir Frederick Bramwell, Sir Frederick Abel, Sir J. Wolfe Barry, and Mr. C. T. Heycock. In October last we described an extension of the City and Guilds (Engineering) College at South Kensington, provided by the munificence of the Company at a capital cost for building of £87,000. The Company also heads the list of grants made by city companies to the City and Guilds Institute with total grants amounting to £204,500, and these represent only part of the generous provision made by the Company for progressive education and science. We have often expressed appreciation of the encouraging attitude constantly displayed by the Company towards scientific activities, and we are glad to offer it our most cordial congratulations upon the wise purposes for which it employs its funds and upon the strength of its present position in national life.

THE interesting collection of prehistoric stone implements from Suffolk, the South Downs, and other British localities formed by Mr. S. G. Hewlett during twenty-five years of personal collecting, has recently been sold at Stevens's auction rooms. Although dispersals are especially to be regretted when objects of local importance are thereby removed from their proper homes, they afford an excellent opportunity for appraising the value which the public sets upon the specialised collections and researches of others. Truth to tell, this sale has shown that these stony and enduring records of early but barbaric man are very far behind the ephemeral postage stamps of his civilised successors in the public estimation. No single implement fetched more than £3. Close on two hundred and fifty lots, comprising 6000 'flints,' passed under the hammer for a total of £293:9s. In detail, 287 palæoliths brought £25:4s., and 1076 neoliths, mostly from the eastern counties of England and the Thames Valley, brought £103:17s., an average of ten to a £1. Those from the South Downs, with others, were sold at about thirty to a £1, and some 300 from abroad only fetched £15:1s. For years we have been stimulated by the sight of long series of such specimens beautifully set out in museums in expensive cases, to wander across ploughed fields and gravel heaps looking in vain for flints that never turned up, but which we had come to regard as of great value. Can it be that the reward for finding them is so small as the Hewlett sale would lead us to suppose? If so, flint-collecting is certainly an appropriate hobby for a poor man of science.

FOLLOWING closely on the announcement of the purchase by the Zoological Society of London of part of the Ashridge Estate as the site for a new Zoological Park, comes the news that Mr. G. B. Chapman, the well-known animal dealer, has purchased the "Withdean Hall" estate, on the London-Brighton Road, which he intends to form into a public zoological gardens. Considering the enormous interest which is taken in animals of all kinds in Great Britain, there is a notable lack of zoological gardens as compared with many other countries, there being only five in Great Britain, while in Germany there are more than twenty, and as many as ninety-two in the United States. Mr. Chapman's new gardens will be laid out on modern lines and the animals will be exhibited under the most natural conditions possible. Cages and bars will be to a great extent eliminated, and their place will be taken by wide ditches over which the animals cannot pass. Mr. Chapman is to be congratulated on his enterprise in providing for the public what will not only be a place of enjoyment and recreation, but also one of the highest educational value.

PROF. E. T. WHITTAKER delivered a lecture on "Present Conceptions of the Cosmos" at Bedford College for Women (University of London) on Mar. 22. Cosmology was founded, he said, in the fifth century B.C. by the Pythagoreans, who first put forward the idea that the earth was spherical; the difficulties they experienced in proving this statement are analogous to our difficulties in establishing present-day hypotheses concerning the size and nature of the whole universe of stars and space. Since the days of the Pythagoreans we have been convinced by experimental evidence that the earth is round and finite, so that there cannot be more than a maximum distance between two points on its surface. The methods of investigation, with the exception of the geodetic, depend on observations made outside the earth, but in considering the whole universe we have no external system of reference. We are apt to be misled by early education, which often implants *a priori* notions concerning space, and obscures the fact that the axioms on which Euclidean geometry is based are not necessarily true from all points of view. Systems of non-Euclidean geometry also have practical applications, and it is possible that on one of these systems as a basis, space may be found to be finite. The distinction between being finite and being unbounded must be clearly made. Space may very well be finite, yet with no boundaries; the traveller through space, unconscious that he is not moving in a straight line, may yet return eventually to his starting-point.

SINCE the Victorian age Prof. Whittaker continued, the theory of relativity has produced a definite advance in the interpretation of the cosmos in terms of a non-Euclidean system. This theory helps to elucidate observations made on the astronomical universe. The number of stars, though immense, is not infinite, and their distance from the earth can be measured. The earth is situated in the Milky Way

or galactic system, and the nearest star is at a distance of about four light years. The spiral nebulae, first discovered by Lord Ross in 1845, are the most distant objects yet observed and are right outside the galactic system; the latter has a diameter of roughly three-quarters of a million light years, while the spiral nebulae are at a distance of from one to ten million light years. It has long been known that the motion of stars towards or away from the earth can be deduced from the shift of the spectral lines; a shift towards the red has been observed in the spectra of the spiral nebulae, and it is therefore concluded that they are moving away from the earth. Einstein's theory of relativity, based on a non-Euclidean system, brings into account the possible curvature of the universe and predicts that a shift of the spectral lines towards the red will be observed for all bodies at a great distance. The diameter of the universe has been estimated from the spectral observations, and is found to be of the order of one hundred million light years. From this point of view, therefore, the universe, though remaining unbounded, may be said to be of a finite nature.

IN his Friday evening discourse delivered at the Royal Institution on Mar. 25, Prof. C. T. R. Wilson stated that much may be learnt about the processes which are going on in a thundercloud by observing the sign and magnitude of the electric field which it produces at the surface of the earth and the sudden changes which lightning discharges cause in this field. These changes are generally of the order of 10,000 volts per metre below the central portion of the thundercloud, of the order of 1000 volts per metre at a distance of 10 kilometres, and they become comparable with the fine weather field of 100 volts per metre at about 20 kilometres. The fields destroyed by lightning discharges are most frequently negative below the thundercloud and positive at great distances. Thunderclouds seem to be essentially bipolar, with the positive charge above the negative. Discharge may occur between the upper and lower poles, between the ground and the lower or more rarely the upper pole, or between the upper pole and the upper atmosphere; combinations of these, either simultaneous or in rapid succession, also occur. From the magnitude of the sudden changes produced in the field by lightning discharges at known distances, the electric moments of the discharges (depending on the quantities discharged and their heights) may be determined. These generally exceed 30 coulomb-kilometres. The quantity discharged in a lightning flash is of the order of 20 coulombs. The potential difference developed in the cloud before discharge is of the order of one million kilovolts, and the energy spent in a lightning discharge is about 10^{17} ergs or 10^{10} joules. Nearly 2000 thunderstorms are on an average in action at a given time, and they may, perhaps, be the main sources of the downward current and positive potential gradient of fine weather regions. In a thundercloud, on account of the great distance through which the intense electric fields extend, effects may be possible which

we cannot hope to produce in the laboratory. It may, for example, be possible for electrons to be accelerated until their energy is some hundreds of times as great as that of any known β -particle.

By electing Dr. H. H. Woollard, at present assistant professor of anatomy and sub-dean of the Faculty of Medical Sciences at University College, London, to the chair of anatomy just vacated by Prof. Wood Jones, the University of Adelaide has once more deprived England of one of her best anatomists, who can ill be spared. Dr. Woollard obtained his M.D. in the University of Melbourne and served throughout the War in the Australian Medical Corps at Gallipoli and in France, eventually attaining the rank of Lieut.-Colonel and being awarded the Croix de Guerre avec Palmes. After the War he joined the postgraduate class of anatomy at University College, London, and was invited to join the staff of the Department. He spent the academic year 1921-22 at Johns Hopkins University as a Rockefeller Foundation Fellow, and on his return to University College was made assistant professor. In addition to a monograph on the anatomy of *Tarsius*, in the main corroborating and extending the pioneer work of Burmeister, he has made exact histological surveys of the cerebral cortex of *Tarsius* and *Oryzeteropus*, and a detailed comparative study of the visual apparatus (retinal and cerebral) in the primates, yielding results of far-reaching value and importance for the student of human evolution. But perhaps his most distinctive achievements are his researches (in particular his application of the methylene-blue technique) on the double innervation of the heart, blood vessels, and striated muscles.

THE Prime Minister's appeal, issued by the Royal Society of Arts, for funds to ensure the preservation of ancient cottages throughout Great Britain, is one which should secure the hearty support of all lovers of beauty, as well as of those who appreciate the fact that these fast-vanishing relics of a bygone day have a value greater than the mere charm of their antiquity to those who seek to interpret the social and economic history of England in the past. Scarcely any material evidence which has survived from those earlier days can serve equally to throw light upon the conditions of agriculture, of rural industry, and of the labourer during the last two to three hundred years or more. Mr. Baldwin's appeal is supported by Mr. Thomas Hardy whose long and intimate acquaintance with rural conditions lends weight to his contention that the ancient type of mud-built cottage is superior to the modern brick structure, not merely on the ground of æsthetic considerations, but also in comfort. The appeal briefly outlines a scheme whereby the fund will endeavour to assist owners financially in securing fitting attention for these ancient cottages and the machinery by which an advisory council will work under the council of the Royal Society of Arts. Donations should be sent to the Secretary, Royal Society of Arts, John St., Adelphi, W.C.2.

THE centenary of the death of Ernst Florens Friedrich Chladni, who has often been called the

father of modern acoustics, occurs on April 3. Chladni was born in Wittenberg on Nov. 30, 1756, and died at Breslau on April 3, 1827. His father was professor of law at Wittenberg, and it was in accordance with his wishes that Chladni also studied law. His natural inclination, however, was towards science, and he once wrote: "As an admirer of music, the elements of which I had begun to learn rather late, that is, in my nineteenth year, I noticed that the science of acoustics was more neglected than most other portions of physics. This excited in me the desire to make good the defect, and by new discovery to render some service to this part of science." He then goes on to show how he initiated the experiments on plates set in vibration in various ways. Taking a hint from the work of Lichtenberg of Göttingen, who had sprinkled fine powders on electrified planes, Chladni obtained those beautiful patterns which are given in most text-books. He next invented two new instruments, the euphone and the clavicylinder, and he spent a good deal of his time travelling and explaining his discoveries. Some of the experiments of Chladni were made known in a book published at Leipzig in 1787, but his fame is mainly due to his "Die Akustik" of 1802. When he visited Paris in 1808, Chladni had an opportunity of explaining his discoveries to Napoleon, who asked the Institute to report on them, and allocated 6000 francs for the translation of the work of Chladni into French. Chladni is also remembered for his views on meteors. His portrait forms the frontispiece of Tyndall's book on "Sound."

AMONG the most active of the scientific bodies of the south-west of England is the Royal Cornwall Polytechnic Society, which has recently issued its ninety-third annual report. Though like similar societies it has its lectures and papers, the Polytechnic Society also maintains a Meteorological Observatory and encourages both art and science in the county by holding exhibitions and awarding prizes, medals, and certificates. The exhibition is held at the same time as the summer meeting, and is supported by the Education Committee of the County Council. The present president of the Society is Viscount Falmouth, and the report contains his address in 1925 on the "Development of Physical Science," in which he traced the work of Röntgen, von Laue, Bragg, Rutherford, and others. Two papers reported in full are those on "The Mining Coinage of Cornwall," by Mr. Newton, and "Boulton and Watt in Cornwall," by Mr. Hamilton Jenkin. Towards the end of the eighteenth century there were more than 400 mines in Cornwall, and from these, practically all the copper used in England was obtained. It was the shortage of government coinage which led to the use of local coins and tokens, and it is of interest to note that many of these coins were made in Birmingham by Boulton and Watt, who were then busily engaged installing their engines in the mines. The Polytechnic Society possesses a large number of letters of Boulton and Watt, and Mr. Jenkin's paper was based on these. Boulton and Watt met with great

opposition in Cornwall, and the troubles drove Watt to distraction. Boulton's instructions to their representatives in Cornwall when carrying out a steam trial are probably unique, for they begin: "Give a drink to all necessary persons and knock any man down that touches the coal or the fire during the whole trial," and ends with "We pray God send you a good deliverance."

HIS MAJESTY THE KING has approved the award of the Royal Medals of the Royal Geographical Society for 1927 as follows: *Founder's Medal*: to Major Kenneth Mason (Survey of India) for his connexion between the surveys of India and Russian Turkestan through the Pamirs in 1913 and his organisation and conduct of the Shaksgam Expedition of 1926; *Patron's Medal*: to Dr. Laue Koch (Copenhagen) for his remarkable six years' exploration of northern Greenland. The Council has made the following awards: *Victoria Medal*: to Col. Sir Charles Close for his distinguished contributions to the advancement of the science of geography; *Murchison Grant*: to Mr. John Matheson for his surveys of Spitsbergen and for his special studies during his long service with the Ordnance Survey in Scotland; *Back Grant*: to Capt. A. H. MacCarthy for his preparation and leadership of the ascent of Mount Logan, 1925; *Cuthbert Peek Grant*: to Mr. Francis Rodd to assist him in further exploration of the Sahara; *Gill Memorial*: to Mr. A. E. Young for his development of the mathematical theory of map projections.

At the annual general meeting of the Chemical Society held on Mar. 24, Prof. H. B. Dixon, Prof. G. G. Henderson, and Prof. A. Smithells were elected new vice-presidents, and Mr. M. P. Applebey, Mr. E. R. Bolton, Prof. J. E. Coates, Prof. J. C. Drummond, Dr. E. K. Rideal, and Prof. J. F. Spencer as new ordinary members of council. Prof. H. B. Baker delivered his presidential address entitled "Experiments on Molecular Complexity," which will appear in the *Journal of the Chemical Society* for April. The anniversary dinner took place the same evening at the Hotel Victoria. The toast of the Society was proposed by Viscount Sumner, while the toast of the guests, proposed by Sir William Pope, was responded to by Sir Ernest Rutherford, Prof. C. Matignon, representing the Société Chimique de France, and Prof. Wilhelm Schlenk, president of the Deutsche Chemische Gesellschaft.

THE next meeting of the International Astronomical Union will be held at Leyden, Holland, commencing on July 5, 1928.

THE council of the Geological Society of London has this year awarded the proceeds of the Daniel-Pidgeon Trust Fund to Mr. William Elgin Swinton, who proposes to undertake the comparison of British Mesozoic Reptilia with those from similar deposits on the continent of Europe.

ON Feb. 24 a dinner was given in honour of Dr. A. P. Coleman, professor emeritus of geology, University of Toronto. It was arranged by some of his colleagues,

former students, and other friends, and it was the occasion of the presentation to the University of Toronto of a portrait of Prof. Coleman, and also of a fund for the maintenance of a gold medal to be known as the Coleman Medal. This medal is to be awarded annually to the student who has obtained, at the time of graduation, the highest standing in his class in geology and mineralogy.

MR. HENRY THOMAS TIZARD, Principal Assistant Secretary, Department of Scientific and Industrial Research, has been appointed by His Majesty the King in Council to be Secretary to the Committee of the Privy Council for Scientific and Industrial Research on the retirement of Sir H. Frank Heath from that office on June 1 next.

MRS. BATESON, widow of the late Dr. W. Bateson, Director of the John Innes Horticultural Institution, Merton, would be glad of the loan of letters written by Dr. Bateson to any readers of NATURE. The letters would be copied and returned without delay unless copies themselves are sent. We are sure that any readers who possess such letters will be glad to assist Mrs. Bateson to bring together correspondence of personal or scientific interest carried on with Dr. Bateson. Communications should be addressed to her at 25 Bolton Gardens, London, S.W. 5.

THE National Research Council of the United States recently granted authority for the establishment of a general committee on the physics of the earth. A number of subsidiary committees have already been elected to deal with such topics as the figure of the earth; seismology; terrestrial magnetism; the age of the earth; the internal constitution of the earth; meteorology; oceanography; and volcanology. The committees are largely American in constitution, but several British scientific workers have been included. Dr. Alfred Harker (Cambridge) has been invited to join the sub-committee on volcanology; Prof. Arthur Holmes (Durham) that on the age of the earth; and Dr. Harold Jeffreys (Cambridge) that on the internal constitution of the earth. The results of the work of the various committees will be published in the Bulletins of the National Research Council.

EXETER has been chosen this year as the centre for the meeting at Easter for regional survey study usually organised by Leplay House. The choice has been determined by the fact that Leplay House and the University College of the South-West at Exeter are co-operating in a regional survey of the south-west of England which, it is hoped, may have a considerable practical effect on the future development of this part of the country. An attractive scheme of study has been planned to cover the period April 14-23, which will include, in addition to the usual lectures and opportunities for individual study, visits to Dartmoor, Crediton, Topsham, and possibly Teignmouth, Dartmouth, and Brixham, thus covering a variety of types of geographical, economic, and industrial conditions in the area. Arrangements are also being made for a summer meeting at Warwick

on Sept. 7-17. Particulars of membership, etc., may be obtained from the Secretary, Leplay House, 65 Belgrave Rd., S.W.1.

THE council of the Institution of Mining and Metallurgy has made the following awards: The Gold Medal of the Institution to Prof. William Frecheville, in recognition of his services to the mining industry during a long and distinguished professional career, and to mining engineering education; The Consolidated Gold Fields of South Africa, Ltd., Gold Medal and Premium to Dr. Sydney W. Smith, for his paper, embodying much original research, on "Liquation in Molten Alloys and its possible Geological Significance"; and the Arthur Claudet Students' Prize to Mr. Robert A. Mackay for a paper on "The Influence of Superimposed Strata on the Deposition of Certain Lead-Zinc Ores."

THE Report of the Secretary of the Smithsonian Institution, submitted on Dec. 9 last, records the acquisition of the Dognin collection of Lepidoptera, by means of gifts from friends amounting to 50,000 dollars. The collection contains 82,000 specimens, of which 3000 are types mostly from the New World, and will thus, it is claimed, give the United States National Museum a better representation of American species in this group than exists in any other museum. In the same report Dr. Walcott states that during

the year the Smithsonian Institution directed or took part in forty scientific expeditions to various parts of the world. Most of these expeditions were for the collection of natural history specimens, and the report emphasises the urgent need for making such collections before more species of animals and plants are extinguished by the rapid encroachments of civilised man. This great activity was rendered possible by the generosity of other organisations and of many private citizens.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A male assistant horticultural instructor at the Hertfordshire Agricultural Institute, Oaklands, St. Albans—The Clerk of the County Council, 23 Castle Street, Hertford (April 14). A head of the department of pharmacy of the Bradford Technical College—The Principal, Technical College, Bradford (April 23). A lecturer in geography (man or woman) at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (May 14). A teacher of woodwork and metal work at St. Olave's School, Tower Bridge, S.E.1—The Head Master. A sanitary inspector in connexion with the Sudan Medical Service—The Controller, Sudan Government, London Office, Wellington House, Buckingham Gate, S.W.1. Civilian education officers of the Royal Air Force—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2.

Our Astronomical Column.

COMETS.—A later orbit of Stearns's comet, including observations up to Mar. 18, has been computed by Messrs. J. P. Möller and Bengt Strömgren (*Copenhagen Circ.* 144).

$$\begin{aligned} T &= 1927 \text{ Mar. } 1.5645 \text{ U.T.} \\ \omega &= 6^\circ 57' 64'' \\ \Omega &= 214^\circ 31' 64'' \\ i &= 87^\circ 8' 15'' \end{aligned} \left. \vphantom{\begin{aligned} T \\ \omega \\ \Omega \\ i \end{aligned}} \right\} 1927.0$$

$$\log q = 0.56575$$

The plane of the orbit agrees well with that found by Mr. L. E. Cunningham, but the date of perihelion is six months earlier, so that no increase in light is to be expected. The comet is, however, an easy telescopic object, and should be followed for several months. The following observation was obtained by Dr. A. C. D. Crommelin:

	R.A. 1927-0	S. Decl.
Mar. 27 ^d 0 ^h 48 ^m 39 ^s U.T.	15 ^h 9 ^m 22 ^s .40	1° 43' 33".2

The comet was about 1' in diameter, with distinct central condensation; the position is in good agreement with that calculated from the above orbit, which is probably near the truth. The following are the positions for 0^h calculated from it:

April 5, R.A. 15 ^h 3 ^m 32 ^s ; N. Decl. 1° 36';
R.A. 14 ^h 57 ^m 12 ^s ; N. Decl. 4° 38'.

Mr. G. Merton has found an image of Pons-Wincke's comet on a plate taken Feb. 25-06804 U.T. R.A. 1927-0, 14^h 4^m 25^s.54; N. Decl. 23° 49' 13".6; magnitude, 15; diameter, 15". He has also measured a photograph of comet Comas Sola taken by Mr. F. J. Hargreaves and gives the following position:

Mar. 23-8729 U.T.; R.A. 1927-0, 4 ^h 36 ^m 26 ^s .67;
N. Decl. 30° 27' 43".5; magnitude, 12.6.

MERCURY AS AN EVENING STAR.—Herr C. Schoch writes to say that he had many replies to his request

for observations of Mercury as an evening star in February (*NATURE*, Feb. 12, p. 252). At Arosa, in Switzerland, it was visible for the first time on Feb. 13, the *arcus visionis* being 10°.2, the same as the value indicated by the old Babylonian observations. The duration of visibility was 62 minutes at Arosa, 66 minutes at Steglitz, the longest duration recorded at Babylon being 72 minutes. He noted the colour of Mercury, seen from Steglitz, as yellow, without admixture of red. Only three reports were received from England, the weather being generally cloudy.

Herr Schoch's latest value of the solar acceleration in a century is 2".98 if measured by the increase of speed, but 1".49 if measured by the distance gained, which is the more usual method. He ascribes the acceleration to the lengthening of the day by tidal friction, and gives the formula, length of day = 24^h (reckoned as in 1900) + 0^s.001947*T*, so that 52,000 years from 1900 will be required to make the day 1 second longer. *T* denotes the centuries after 1900.

SOUTHERN DOUBLE STARS.—Mr. W. H. van den Bos, who is observing southern double stars, gives a third list in *Bull. Astron. Instit. Netherlands*, 3, 114, containing 423 new pairs and bringing his total discoveries to 634, of which 50 are nearer than 0.24", 104 between 0.25" and 0.54", and 87 between 0.55" and 1.04". Very few are of types *B* and *M*. More than one-third are of type *G*, the order then being *A*, *K*, *F*. ψ Sagittarii is an interesting star. The magnitudes are 5.5, 6.0, separation 0.2", spectrum *F*5. This has also been observed as a spectroscopic double at the Lick Observatory station at Santiago; both spectra visible, relative velocity 130 km./sec. Mr. van den Bos says "This can hardly relate to the visual pair, unless the eccentricity and inclination are large, the period short, and the spectrograms taken near the node."

Research Items.

ORIENTATION OF CHURCHES.—In a lecture on "The Orientation of Churches," recently delivered to the members of the Sidmouth Literary Society, the Rev. John Griffith paid a whole-hearted tribute to the work of Sir Norman Lockyer in the study of stone circles from the astronomical point of view. His attention was first directed to the subject by an article by Sir Norman on "The Agricultural Divisions of the Year" in *NATURE*, in which it was pointed out that the orientations of stone circles grouped themselves around February, May, August, and November. This 'farmer's year' was based upon a division of the year with which he himself had been familiar from boyhood and, as he had at once pointed out to Sir Norman, coincided with the Celtic divisions of the year of tradition and folklore; while English fairs, as dated at the beginning of the last century, clustered around these four points. These facts indicate a continuous calendrical usage from the present day back to the stone age, over a period of 4000 years. Stimulated by this result of the application of astronomical methods to the study of ancient monuments, Mr. Griffith has devoted himself to investigating the orientation of the older churches of Great Britain and has obtained similar results. He finds that, allowing for a difference of five days in the calendar between the twelfth century, when most of those churches were built, and the present day, there appears to be evidence of dedication to a popular saint, who often differs from the official patron saint. In Wales the choice is generally limited to four saints, Mary, Michael, Peter, and John the Baptist, while everywhere the feast of St. James with St. Philip on Mayday is popular as occupying a seat which, since the dawn of traditional history, has been held by one pagan deity or another.

REST PERIODS IN NEW GUINEA.—In *Man* for March, Prof. C. G. Seligman describes the alternation of rest and work periods among the Sinaugolo of Rigo District, New Guinea. Among this people the *dubu* could be built and the great feast, the *tabu*, be celebrated only during the *kabu* period; while in the period known as *dauka*, intervening between two *tabu* feasts, the drum was not sounded or the customary small feasts held, while only those known as *dauka*, feasts accompanying payment for a wife, and death and mourning feasts, could take place, dancing being to the accompaniment of bamboo dancing sticks and not the drum. Food was not piled on the *dubu* but on temporary platforms. Otherwise life proceeded as usual, and the customary hunting, fishing, planting, and sexual taboos were observed. A *dauka* period recurred every second or third year. According to the explanation of a Sinaugolo headman, these periods were instituted to secure the proper observation of these ceremonies, and a relaxation from the toil of ordinary life represented by the *dauka* period. In the *tabu* feast itself all neighbouring and friendly villages take part, but it is given by one portion of a village or by a clan, though sometimes two clans united for the purpose. The preparations involved the collection of stores of food under a taboo. Food for the first ceremony, the *kidua*, is collected from neighbouring villages, this virtually constituting an invitation and acceptance of an invitation to the feast. This food was distributed to the visitors from neighbouring villages in the *kidua* ceremony. On the next day the pigs given at the *baiseno*, a dance preceding the *tabu* feast by about a month, were hung to the *dubu*. Then follows the giving away of the *tabu*, an essential feature of which was the boasting of the men with the object of

instigating visitors to undertake the next *tabu*. For the next two or three days feasting follows, in which the pigs given at the *baiseno* are killed and eaten.

EARLY CHINESE CARTOGRAPHY.—The oldest two maps of China known to exist were found some years ago at Hsianfu, the capital of the Shensi province, and were described by Prof. E. Chavannes in 1903. These maps formed the subject of a lecture by Prof. W. E. Soothill to the Royal Geographical Society on Mar. 14. They are engraved on stone, and preserved among other stone tablets. Chavannes dated the earlier of these maps 1043, but it is less easy to decide the date of the map from which much of it was copied. Prof. Soothill's conclusion is that the larger map is part of Chia Tan's map completed in A.D. 801, and that it may have been based on P'ei Hsiu's maps of the third century, not directly, but rather on copies elaborated by local cartographers. He believes that, with some change in names, it may be taken to represent China as it was known in the eighth century. The second map would appear to be more recent. It lacks the marginal notes of the other, and is covered by a grid of 100 li squares. Prof. Soothill thinks that it was drawn by an unknown cartographer some time during the three centuries preceding A.D. 1100, that is, after the time of Chia Tan. It suggests an endeavour to reconstruct P'ei Hsiu's lost map, using his net system, but it shows an advance in accuracy from Chia Tan's time.

ESKIMO IN EAST GREENLAND.—In a lecture to the Royal Geographical Society on Mar. 21 on the Cambridge expedition which he led to East Greenland last summer, Mr. J. M. Wordie referred to the traces of former Eskimo habitation which occur on that coast. A search of the coast region between Sabine Island and Scoresby Sound revealed a number of tent rings, groups of winter huts, and a few graves. Clavering Island is rich in remains: some regions, on the other hand, showed no traces. The conclusion is that the Eskimo can never have been very numerous on the east coast, and Mr. Wordie believes that the evidence points to only one period of immigration during which the Eskimo arrived by the north of Greenland. This is a reversion to the earlier views of H. P. Steensby, who held that the Eskimo followed the musk-ox by that route. Recent examination of the north coast of Greenland by K. Rasmussen renders that route unlikely, not merely in the lack of Eskimo remains but in the absence of game or possible hunting grounds and the bad travelling conditions. Mr. Wordie visited the new Eskimo settlements formed by the Danish Government on Scoresby Sound, which are composed of Eskimo of pure stock from Angmagssalik, the one surviving Eskimo settlement from the original colonisation of that coast. If game resources last, the prospects of these new colonies are good, but it must be remembered that the disappearance of the majority of the east-coast Eskimo during the nineteenth century was probably due to the exhaustion of resources. The same might occur again.

FISHERY INVESTIGATIONS AT CULLERCOATS. The results of the investigations carried out at the Dove Marine Laboratory, Cullercoats, during the year ending June 30, 1926, are given in Report 15 (N.S.), which has recently been issued by the Laboratory. Mr. Storow and Mrs. Cowan deal with their observations of the length, age, growth, and sexual condition of some 4600 herrings from commercial landings from the Shetlands, Firth of Forth, East Anglia, north-west and south of Ireland, Irish Sea, and Clyde. Mr. Gill, biochemist at the laboratory, gives a preliminary

description of some investigations regarding the characterisation of the flesh protein of the herring, the subject being attacked from the point of view of the amino-acids present. Mr. Gill also reports on his estimations of the quantity of dissolved oxygen in the waters of the River Tyne. The percentage in the tidal region follows very closely the amount of fresh water coming down the river, both being at a maximum in the winter and at a minimum in the summer. Heavy rains, however, even for a few days, can raise the oxygen content of the estuary from its low summer values to the high winter values. Mrs. Cowan describes the growth under aquarium conditions of the lump sucker (*Cyclopterus lumpus*) reared from the egg. Prof. Meek deals with some interesting replies to a letter circulated among fishermen and fishery officers requesting their opinions on the currents along the east coast of Great Britain.

VARIATION IN EARWIGS.—The bimodality of the curve for forceps-length in male earwigs (*Forficula*) has been well known since the original observations of Bateson and Brindley in 1892. Diakonov in 1925 published further evidence, from material collected in Russia, that the forceps are dimorphic and that the difference is probably not a genetic one but represents two independent positions of equilibrium for forceps development. He also showed various relationships between forceps-length and body-size, but the data were not fully analysed. Prof. J. S. Huxley (*Jour. of Genetics*, vol. 17, No. 3) has now published the original measurements and added a further analysis of this apparently unique type of dimorphism. He finds that plotting the logarithm of forceps-length against the logarithm of body-length gives a straight line, indicating that this organ has the same growth-mechanism as other organs showing heterogonic growth. With increasing body-size there is a tendency for the forceps to shift from short to long, the forceps of the largest animals always coming in the long group. In a colony under unfavourable conditions there was a decrease of mean body-size, but the means of forceps-length were scarcely affected. Nevertheless, the percentage of individuals in the population with short forceps was considerably increased. Similarly, more favourable conditions shift the forceps-length of some individuals during their development from the short to the long type. But there is still no evidence as to why there should be two positions of stability in forceps-length with a gap between them. This can probably only be determined by experiment.

MICRO-ORGANISMS IN TICKS.—Part I. of the 11th and 12th Reports of the Director (Sir Arnold Theiler) of Veterinary Education and Research of the Union of South Africa (Pretoria, Sept. 1926, 817 pp.) contains twenty-six papers ranging over the varied work of this active Department—serological investigations and other studies on blood and on inoculation, protozoology, helminthology, entomology, and studies on grasses and other plants. Attention may be directed to the account, by Dr. E. V. Cowdry, of a group of micro-organisms transmitted hereditarily in ticks and apparently unassociated with disease. These organisms are pleomorphic, bacterium-like, and intracellular, and they stain much less intensely with ordinary methods than most bacteria. They were found in fifteen different species of ticks, including representatives of the Argasidae as well as the Ixodidae. No evidence could be found of injury to the tissues of the ticks other than physical distention of the cells to accommodate large numbers of the organisms. They were found in every tick examined, not only from South Africa but also from Jamaica, Trinidad, Honolulu, and several parts of the United States; and as

they were present in the eggs of ten species and in the unfed larvæ of seven species, it was concluded that transmission was hereditary. The organisms in several respects resembled Rickettsia, but were of larger size. They also resembled the symbionts of certain lice and blood-feeding flies, but they never gave rise to definite organ-like structures comparable with the mycetozoa, and they were restricted to the Malpighian tubes and the eggs, whereas the symbionts referred to are confined to the digestive tract.

THE UTILISATION OF POLLEN BY THE HONEYBEE.—In a paper entitled "The Collection and Utilisation of Pollen by the Honeybee," published as Memoir 98 (June 1926) of the Cornell University Agricultural Experiment Station, Mr. Ralph L. Parker contributes observations of considerable interest. Pollen is known to be the chief source of protein in the food of bees, and a lack of it reacts deleteriously upon the developing brood. The adult bees use the nitrogenous material of pollen in the elaboration of the brood food that is fed to the larvæ for the first two days after eclosion from the egg. This predigested food is fed to the queen all through her larval life. The worker and drone larvæ, on the other hand, are fed afterwards with a mixture of honey and undigested pollen. Substitutes for pollen such as rye, oats, corn, pea-meal, etc., were not found to be beneficial. The feeding with such substitutes is a failure, since, although it may stimulate egg-laying by the queen and brood-care by the workers, larval development is not completed. Some of the simple sugars and proteins of pollen are available to the bee, but most of the other contents are not available. Proteolytic enzymes have been shown to be present in the bee's alimentary canal, but the actual proteins of pollen utilised by that insect have not, so far, been identified. Bee-keepers in regions which at times experience a shortage of pollen during the beginning of the season, are advised to preserve combs of pollen for use during such an eventuality, since no efficient substitutes can be recommended.

ORE DRESSING IN CANADA.—The Annual Report of Investigations in Ore Dressing and Metallurgy for 1925 by the Mines Branch of the Canadian Department of Mines has just been published and shows evidence of very active work. A number of complex ores, e.g. silver-lead-zinc, gold-copper, copper-lead-zinc, etc., have been investigated, and satisfactory methods for the treatment of the ores have in most cases been devised. A new process is outlined for the treatment of ilmenite, producing a titanium oxide concentrate capable of being used for the production of pigment and other purposes. Detailed reports upon the concentration by flotation of Canadian molybdenite and graphite ores are also included. It is evident that this section of the Department of Mines is doing excellent service in the development of the Canadian mining industry.

THE PALAGONITE FORMATION OF ICELAND.—The first of a series of papers describing a comprehensive study of the Icelandic eruptives (based on a collection made in 1924 by Dr. G. W. Tyrrell and Dr. M. A. Peacock) appears in the *Trans. Roy. Soc. Edin.*, vol. 55, Pt. 1, No. 3, 1926. It consists of a preface to the series, followed by an account of the basic tuffs by Dr. Peacock. These are either sideromelan-tuffs or palagonite-tuffs. The former consist of basalt glass which has been drastically chilled and fragmented owing to the sub-glacial extrusion of basalt magna. The palagonite-tuffs are the older sideromelan-tuffs which have been hydrated, usually by submersion beneath the sea or by hot springs. It is shown that palagonite is essentially the hydrogel of sideromelan, the hydration being accompanied by a partial loss of

lime and soda and an almost complete oxidation of iron. The palagonite due to submersion is an isotropic yellow gel, but in that due to the action of hot springs there is an obscurely birefringent fibrous structure. Both types are unstable and tend to crystallise with loss of part of the water into chlorites and zeolites. It is suggested that Fermor's proposal to use the term *palagonite* for chlorophæite and other late-magmatic hydrous residual materials in basaltic rocks should be discontinued, since the latter, though of somewhat similar composition to that of the Iceland palagonite, have originated by an entirely different process.

THE COMPOSITION OF METEORITES.—In the *Proc. Amer. Phil. Soc.*, vol. 65, No. 2, p. 119, G. P. Merrill summarises recent work on the chemical and mineral composition of meteorites. The chief point of interest is the result of a series of carefully conducted analyses of representative masses. Twenty-eight terrestrial elements have so far been detected, among those not found being antimony, arsenic, barium, strontium, fluorine, lithium, tin, lead, zinc, and gold. This is a particularly significant list, for it includes many of the common ore- and gangue-making elements that are associated with the continental rocks of the earth. The characteristic ore-making elements of norites and peridotites, such as copper, cobalt, nickel, and the platinum group, are all present, as would be expected. The minerals of meteorites are in many cases of a type that can be accounted for, provided that oxygen was relatively deficient in the medium from which they crystallised. It is pointed out that nothing akin to rocks of the granite family has been found in meteorites; and further, that meteorites have never been found in terrestrial beds of any geological horizon but the most recent. Merrill regards the possible meteoric origin of tektites as still unproved.

COAL CARBONISATION.—On Feb. 8, 1927, Dr. C. H. Lander, Director of the Fuel Research Board, read a paper before the Institution of Petroleum Technologists on "The Production of Oil from Coal." The history and work of the Fuel Research Department, which set out to study this problem in particular, was surveyed. The most interesting part was a disclosure of recent experience with vertical retorts of cast iron. Coal has been carbonised at 625° continuously in this retort setting, from March to December 1926, when it was let down for inspection. These retorts, which are again in use, are stated to have been easy to operate, and the coke product has given satisfaction to consumers. Yields of tar reaching 18 gal./ton were obtained, and it is believed that the retorts approach technical success. More experience of protracted working is necessary before commercial success can be assessed.

IRREGULAR EMISSION OF X-RAYS.—Any experimental work with X-rays in which unusual discontinuities are recorded is now of particular interest, in view of its possible bearing on the *J*-phenomena which are being investigated by Prof. Barkla and his school. It has already been shown that in certain circumstances the relation between the intensity of a number of characteristic rays and the voltage on the bulb changes abruptly at about 4.5 times the minimum potential required for the excitation of each. D. Nasledow and P. Scharawsky, working in the X-ray Institute at Kiew, now report similar changes when a Müller tube of the hot filament type is run at constant voltage and with a variable current (*Zeit. für Phys.*, 41, p. 155, 1927). The *K_α* and *K_β* lines from a copper target were separated by reflection from calcite, and their intensities were measured by an ionisation method. When less than 4 milliamperes were passing through the bulb, the intensity of either

line was closely proportional to the current; for greater currents the rate of increase was linear, but less rapid than before. A break still took place at 4 millamp., when the exciting peak voltage was raised from 30 kilovolts to 45 kilovolts. No explanation is offered of these results—which the authors propose to extend—but the apparatus appears to be described in sufficient detail to permit of comparison with the experience of other workers in this field.

FORMS OF SULPHUR TRIOXIDE.—The *Gazzetta Chimica Italiana* for Jan. 1927 contains a series of memoirs by G. Oddo and A. Casalino on the different forms of sulphur trioxide, which were studied some years ago by Oddo. The vapour density of the liquid form at 25° is only slightly above the value for SO₃, although slight association may be present. The amorphous and fibrous solid varieties gave molecular weights about 83.77 as a mean. The solutions of the trioxide in phosphoryl chloride were found to give solid solutions in all proportions, and the results of the depression of freezing-point were therefore irregular and unsuitable for the determination of the molecular weight. In anhydrous sulphuric acid the molecular weight of the liquid form was 80, of the fibrous form 88. The papers contain a detailed description of the preparation of the different forms of sulphur trioxide and of the transformation of one form into another.

MAGNETIC OBSERVATIONS IN AUSTRALIA. Magnetic observatories in the southern hemisphere are so few that it is an event of some importance when a new one is instituted. For many years, only one magnetic observatory was in operation in Australia, at Melbourne, and even this was of limited service to magnetic science owing to the non-publication of its observations. Gradually this observatory became disturbed by electric tramways, and in 1919 a new observatory, 34 miles away, was built. The magnetograph house is above ground, and consists of a chamber within a chamber, the walls being well lagged to reduce temperature changes. No attempt is made to control the temperature of the inner room by artificial heating. There is no resident observer, the records being changed by a local resident, who also registers a time-break at the beginning and end of each record. The records are posted weekly to Melbourne for development and computation: an observatory official visits the station monthly to make absolute observations for base-line values, and to execute any necessary adjustments. The magnetographs are of the Eschenhagen type; the absolute instruments include a Kew magnetometer and a Schultz earth inductor. During 1924, which appears to be the first year for which hourly observations are published, the vertical force instrument gave considerable trouble, there being large changes in scale value and base line; the horizontal force magnetograph had a nearly constant scale value. The results are given in an (undated) publication, "Melbourne Observatory: Hourly values of the magnetic elements at Toolangi in 1924." It is very satisfactory that the Director, Dr. J. M. Baldwin, has been able both to institute this new observatory and also to obtain publication of hourly values of the elements, a course which places the observations so fully at the disposal of investigators of terrestrial magnetism. It is to be hoped that in time the Government of Victoria may provide the funds necessary for a resident observer, without which it is impossible to maintain a magnetic observatory with full efficiency. The only other magnetic observatory in Australia is the one recently instituted by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington; it is situated near Perth, Western Australia.

The Botany School of the University of Sydney.

THE opening of the new Botany School in the University of Sydney is an event not only important for the British Empire, but also for the world at large. The building is in modernised perpendicular Gothic and harmonises with the main structure of the University of Sydney, which presents some interesting resemblances both in its architecture and its origin to the well-known main building of the University of Toronto. The construction is in stone, and the building is so arranged that it will be an ornament to the University for many years. Although architecturally attractive, it does not represent the petrification of the science in the Pierian springs of architecture rightly dreaded by Thomas Huxley, for it is thoroughly well lighted, spacious,

before long, be remedied in view of the great interest which the public in Sydney has begun to take in botanical science.

A physiological laboratory is also among the rooms in the Botany School, and it supplies excellent facilities for the prosecution of that important side of the science. Numerous research rooms for the staff and advanced students are included in the plan of the building, and last, but not least, the lecture theatre is capable of seating two hundred students.

The building was formally opened on Nov. 6, 1926, in the presence of the Governor of New South Wales, the Vice-Chancellor of the University, and Prof. Anstruther Lawson, the head of the school. Prof. E. C. Jeffrey, of Harvard University, was present as

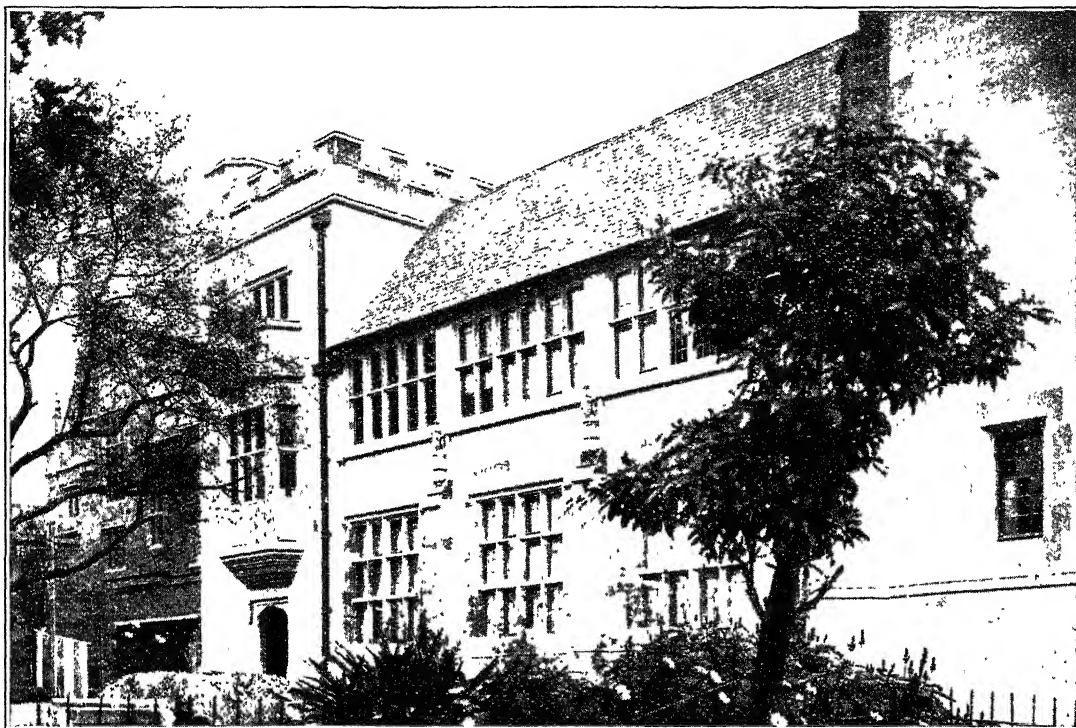


FIG. 1.—Botany School of the University of Sydney, N.S.W.

and in every way practical. The entrance is adorned by representations of some of the great masters in the science. The idea of commemorating the great, however, is not confined to the exterior of the building, for the laboratories and other work-rooms are named after distinguished botanists. The botanical museum bears the names of Bentham and Hooker, and its windows show the portraits of such outstanding botanists as Hofmeister, Grew, Sachs, Nageli, Hooker, Bentham, and others. The herbarium, which is spacious and well equipped, is named after John Ray, and in its windows appear effigies of Morrison, Ray, Tournefort, De Jussieu, Linnaeus, Robert Brown, etc. The advanced laboratory is named after Charles Darwin. The research laboratory bears the name of Robert Brown, while the first-year laboratory is named after Sir Joseph Banks, two names so signally connected with the beginnings of Australian botany.

The library and reading-rooms provide abundance of space, but the shelves are as yet meagrely lined with books. It is hoped that this shortcoming may,

guest of honour to deliver an address and also the formal felicitations of this University.

The opening of the new Botany School in Sydney University is a scientific event of the first magnitude, because it supplies an equipment in the southern hemisphere in every way adequate for the carrying on of botanical investigation. The facilities provided by the Botany School, in fact, compare most favourably with those which are offered by the larger universities in the northern hemisphere. In his remarks Prof. Jeffrey referred to the great advantages which Australasia presents to the students of plants, combining as it does a great variety of environment with healthful conditions of existence and a stable and well-organised government. Australasia, in fact, unites to a large extent the advantages of the tropics with the comfort and salubrity of temperate regions. The flora of Australia is quite as interesting as its fauna, but not nearly so well known. It was suggested, further, that it would be a great advantage if every student of botany in

the northern hemisphere could some time or other visit Australasia. Prof. Lawson, in the name of the University, offered the full hospitality of the botanical laboratory to visiting botanists.

The Botany School of the University of Sydney is a monument to the zeal, capacity, and artistic sense of Prof. Anstruther Lawson. The school has already a large and growing body of students and a highly creditable list of published researches.

E. C. J.

Animal Breeding Research Department, University of Edinburgh.

WE have received from the Director, Dr. F. A. E. Crew, the sixth annual report of the Animal Breeding Research Department of the University of Edinburgh. This department has recently received two large benefactions, namely, £10,000 from Lord Woolavington toward a fund for converting the directorship into a University chair, and £30,000 for general purposes from the Rockefeller Fund, so that the Department has the happy prospect of enlarging the scope of its work.

The report before us contains the list of a large number of problems of inheritance which are being attacked, but the progress made with the solution of any of them seems to be but moderate. All of them will require a long stretch of years before any considerable advance is made towards their solution, and in the case of domestic animals, the numbers with which it is possible to deal are too small to justify a successful analysis into Mendelian 'factors.'

More striking results are obtained from the investigation of endocrine reactions. We may direct attention to some extremely interesting results of extirpation of gonads in the mouse obtained by Mr. Kasur. The weight of the male remains unchanged, that of the female increases, but the kidney of the normal male is much heavier than that of the normal female, whereas the thymus and spleen of the former are considerably lighter than those of the latter. After castration the kidney of the male decreases whilst the thymus and spleen increase in weight, so that in all these respects the animal approaches the female type.

Another thought-provoking result was obtained by Mr. A. W. Greenwood acting in collaboration with the Director. He grafted into the body of a female chick four days old, after removing her ovaries, the testes of her brother. The bird assumed the plumage of the cock. This is in accordance with Zawadowsky's interesting results, in which he converted a cock into a hen and vice versa by the transposition of the gonads. But in the case under consideration the bird, after a subsequent moult, reverted to the plumage of the hen. A post-mortem examination revealed the fact that a small fragment of the functional left ovary had been left in the body by the operation, but that this remnant had degenerated. Not only, however, had the testis grafts survived and produced an abundance of testicular tissue, but ovariectomy had stimulated the vestigial right ovary to activity and it had also produced testicular tissue, so that the bird was in fact over-masculinised. Messrs. Greenwood and Crew advance the hypothesis that the ovary exercises a heavier drain on metabolism than the testis, and that the distinction between male and female secondary sexual characters is due to the degree of strain exercised on the organisation by the respective gonad in each case. If the testis is artificially increased in bulk beyond the normal, it exercises a strain equal to that of the ovary, and hence the secondary sexual characters of the female are produced.

E. W. M.

Experiments on Molecular Complexity.

PROF. H. BRERETON BAKER, for his presidential address at the annual general meeting of the Chemical Society on Mar. 24, chose as his theme "Experiments on Molecular Complexity." He had claimed that, like Sir Isaac Newton, "hypotheses non fingo," but, speaking later at the anniversary dinner, admitted that he was an inveterate maker of hypotheses, which, however, he forbore to publish.

The investigations described in the address arose out of the observation, some five years ago, that if liquids of very varying types were subjected to prolonged drying, the boiling points were raised to a very considerable extent. This rise, ascribed to an increase in the complexity of the molecules, takes place with typically unassociated liquids; hence it may be that all liquids are capable of association. Since water can also promote dissociation, it is conceivable that its absence might influence the molecular complexity in opposite directions; so far, however, dry liquids boiling at subnormal temperatures have not been obtained, although dry benzene has been separated into fractions boiling at 80° and 118° respectively. Further researches were carried out to see if catalysts other than water are effective, the experimental methods involving measurements of vapour density and surface tension.

Preliminary experiments in barometer tubes with very pure sugar charcoal gave definitely positive, although not quantitatively reproducible, results. For example, the vapour pressure of ethyl ether at 16° was raised by 25 mm., of methyl alcohol at 35° by 12 mm., and of benzene at 23° or 37° by 2 mm. Prolonged experiments with Smith and Menzies' methods still gave variable results—a circumstance which has led Prof. Baker to two somewhat important deductions. First, a catalyst evidently acts very slowly, and sometimes in a direction contrary to that shown in the final equilibrium; secondly, a pure liquid appears to have no constancy of composition, but possesses a vapour pressure which depends on the history of the specimen. It therefore became necessary to employ a method by which the vapour pressure of the liquid could be balanced against that of the liquid with the catalyst.

Such a method made use of a U-tube containing mercury, the horizontal upper ends each carrying a pair of bulbs, and being connected by a capillary tube. The liquid could thus be distilled on to a catalyst, the capillary junction closed, and the difference arising between the vapour pressure of the pure liquid and that in contact with the catalyst could be directly measured. Acetic acid, benzene, methyl alcohol, ether, and bromine were examined, the catalysts being charcoal, platinum black, or thoria. In every case the catalyst caused an increase in the vapour pressure of the liquid; such a difference was, indeed, clearly apparent in a sample tube exhibited. An even more striking exhibit was a two-limbed tube in which, three weeks previously, accurately measured equal volumes of bromine had been placed, one of the limbs also containing charcoal. After evacuation, the tube had been sealed; so much bromine had afterwards distilled from the limb containing the catalyst that the charcoal was left almost dry. A refinement of the barometer tube method showed that the difference was increased by heating and diminished by cooling; heating and afterwards cooling to 20° always caused an increase in vapour pressure, and cooling the reverse, the original value for a particular catalyst being restored only after some weeks.

For the surface tension measurements Ramsay and Shields' method was employed, the diameters of the

specially resistant capillary tubes being determined directly to one-thousandth part of a millimetre. Comparison tubes were, of course, always used. It was noteworthy that the pure liquid, for example, acetic acid, does not reach its normal value until three weeks after filling the tube, the process of boiling to remove air clearly causing dissociation. Thus, after 2 days the molecular weight was 1.568×60 , and after 3 weeks or 9 months, 2.097×60 . Heating for a short period in most cases increased the molecular complexity, whilst heating for a long period decreased it. The catalyst, which gave a molecular weight value for acetic acid (measured after 3 weeks) of 2.525×60 , did not immediately produce its maximum effect on the complexity of the molecules.

Prof. Baker considers that all liquids may be regarded as analogous to a dissociable gas such as nitrogen tetroxide, the processes of association and dissociation, however, being much slower for liquids than for gases. The effect of the presence of solid catalysts, as would be expected, is much slower for the liquid than for the gaseous condition, and it is difficult to understand how their special influence is exerted. The president acknowledged the help given to him by his assistant, Miss Margaret Carlton, who has done a considerable portion of the experimental work.

University and Educational Intelligence.

EDINBURGH.—Mr. V. Gordon Childe has been appointed by the University Court as the first occupant of the Abercromby chair of archaeology. This chair was founded in 1925 in accordance with a provision for its endowment in the will of the late Lord Abercromby, the well-known archaeologist and authority on the pottery of the bronze age in Britain. Mr. Childe was educated at the University of Sydney, where, after taking his M.A. degree, he was awarded a classical scholarship tenable at Oxford. He became a member of Queen's College, Oxford, in 1914, took his B.Litt. in 1916, and a first class in the honours school of *Literæ Humaniores* in 1917. After a short period spent in Australia, Mr. Childe returned to England, and since then has been engaged in archaeological research and has acted as librarian of the Royal Anthropological Institute. He has published a number of papers in archaeological periodicals and two books of great erudition and originality in the History of Civilisation Series—"The Dawn of European Civilisation" and "The Aryans."

LEEDS.—The Miners' Welfare Committee has offered a contribution of £10,000 towards the cost of erection of a new building for the Mining Department of the University. This shares with the Department of Coal Gas and Fuel Industries a building which was erected in 1906, but now, owing to the growth of both departments, it has become inadequate. The Department has received loyal support from the industry. Since 1899 the West Yorkshire Coal Owners' Association has made an annual grant, and has recently contributed £25,000 to the University Development Fund, while contributions from individual members of the mining industry amount to more than £2500. The support thus given by the industry may not improbably result in the Mining Department being the first part of the building scheme to be undertaken.

LONDON.—Mr. W. E. Le Gros Clark has been appointed as from Sept. 1 to the University chair of anatomy tenable at St. Bartholomew's Hospital Medical College. In 1924 Mr. Clark was awarded the Hunterian Medal for anatomical research, and was elected a member of the Board of Examiners for the

Fellowship of the Royal College of Surgeons. He has published numerous contributions on the skulls of primates in the *Proceedings of the Zoological Society*, *Journal of Anatomy*, and similar publications.

Dr. Hamilton Hartridge has been appointed as from Sept. 1 to the University chair of physiology tenable at St. Bartholomew's Hospital Medical College. Dr. Hartridge has been a fellow of King's College, Cambridge, since 1912, and was awarded the Horton Smith Prize in 1918. Since 1919 he has been lecturer on organs of special sense and senior demonstrator in physiology at the Physiology Laboratories, Cambridge. He has published numerous papers in *Proceedings of the Royal Society*, 1922-25, *Philosophical Magazine*, 1923, and the *Proceedings of the Cambridge Philosophical Society*.

The following Doctorates have been conferred: D.Sc. in statistics on Mr. A. E. R. Church (University College), for a thesis entitled "On the Means and Squared Standard Deviations of small Samples from any Population"; D.Sc. in physics on Dr. R. C. Johnson, for a thesis entitled "The Structure and Origin of the Swan Band Spectrum of Carbon," and other papers.

OXFORD.—The Delegacy for Extra-Mural Studies has arranged a special course of zoology, primarily for teachers of science in secondary schools, on Aug. 2-12. The course, which is part of the annual summer meeting organised by the Delegacy, will deal mainly with recent developments in zoology. Further particulars and application forms can be obtained from the Rev. F. E. Hutchinson, Acland House, Broad Street, Oxford.

THE annual value of the Beit memorial fellowships for medical research has been increased and will take effect as from October 1 next. An election of junior fellows will take place in July next. Applications upon a prescribed form must be sent on or before June 1 to Sir James K. Fowler, Honorary Secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, W.1.

THE Air Council has decided to increase the number of prize cadetships in the Royal Air Force offered for competition annually from three to twelve. These cadetships enable boys to complete the two years' course at the R.A.F. Cadet College, Cranwell, at a cost of only £40 in all to their parents. Candidates are selected at an examination held by the Civil Service Commission in June and November; they must be between 17½ and 19½ years of age, and must be in possession of School Certificate A or B. Applications for the June examination must reach the Civil Service Commission on or before May 4. Further information can be obtained on application to the Secretary, Air Ministry, London. W.C.2.

THE list of "Students from other Countries in the Universities and University Colleges of Great Britain and Ireland in October 1926," issued by the Universities Bureau of the British Empire (50 Russell Square, London, W.C.1), contains more than its title suggests. It is a register of the names of students from other countries attending each institution of university rank, and may appear, therefore, to have either the virtues or vices of a public card-index according to the purpose or predilection of the person seeking the type of information afforded by a list of actual names. It is to be noted, however, that on one page the number of students from each country is set out. The following extracts from that page may not be without significance: Africa, 1054; America, 824; Asia, 1754; Europe, 643; The Pacific, 321.

Calendar of Discovery and Invention.

April 3, 1449.—In the Patent Roll, 27 Henry VI., Part 2, No. 468, is the grant of letters patent, dated April 3, 1449, to John of Utynam, born in Flanders, for the exclusive right of making coloured glass for twenty years. This is the earliest known example of an industrial monopoly patent in England or elsewhere. John came to England at the King's command to make glass for Eton College and St. Mary and St. Nicholas College, Cambridge, and because the said art had never been used in England and John intended to instruct divers lieges of the King in many other arts never used in the realm, the King granted that no liege of the King learned in such arts was to use them for a term of twenty years against the will and consent of John under a penalty of £200.

April 4, 1879.—During the course of his lectures at Birkbeck College, Chaloner remarked, "The man who eliminates phosphorus by means of the Bessemer converter will make his fortune." This chance remark fixed itself in the mind of Sidney Gilchrist Thomas, the police-court clerk, who after some years' experiments solved the problem, and in 1877 and 1878 took out patents for the manufacture of 'basic' steel. He was assisted by several metallurgists, but it was Windsor Richards who on April 4, 1879, made the first successful experiments on a large scale, these being carried out at the works of Bolckow, Vaughan, and Co., Middlesbrough. Thomas reaped a fortune, but died at the early age of thirty-five years and was buried in the Passy Cemetery, Paris.

April 5, 1864.—An important improvement in photography was announced by Swan in his paper on the new carbon process read to the Photographic Society on April 5, 1864. Swan employed a tissue "as pliant as paper, and as transparent and smooth as glass, formed of collodion on the one side, and of gelatine impregnated with ammonium bichromate, carbon (indian ink) and saccharine matter (sugar) on the other." Swan's process was at once adopted, notably in France, and to it we owe the finest reproductions of famous pictures.

April 6, 1911.—Leaving New York in the *Roosevelt* in July 1908, Peary again set out for the Arctic, and on April 6, 1911, reached the North Pole, "the crowning result of twenty-three years' devotion to Arctic exploration."

April 7, 1795.—Before the Revolution there was no uniformity in French weights and measures. On May 8, 1790, the Constituent Assembly therefore charged the Paris Academy of Sciences with the organisation of a better system. Lagrange, Laplace, Cassini, Mechain, Lavoisier, Delambre, Prony, and others took part in the work, but it was the measurement of an arc of the meridian from Dunkirk to Barcelona by Delambre and Mechain which led to the adoption of the metre— $\frac{1}{10,000,000}$ th part of the distance from pole to equator—as the standard of length, this important unit being made legal on April 7, 1795. The whole metric system of weights and measures was completed in 1799, and was made the only legal one on Nov. 2, 1801.

April 8, 1838.—Regular trans-Atlantic steam navigation was inaugurated by the s.s. *Great Western*, which left Bristol for New York on April 8, 1838. She was a fine wooden paddle-wheel vessel, especially designed by Brunel for this traffic, and was the most remarkable ship of her day. Other steam vessels such as the *Savannah*, H.M.S. *Rhadamanthus*, *Curacoa*, and *Royal William* had crossed the Atlantic before, but were quite unsuitable for continuous steaming, while the first Cunarder, the *Eritannia*, did not begin running until 1840.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, Mar. 24.—Sybil Cooper, D. E. Denny-Brown, and Sir Charles S. Sherrington: Interaction between ipsilateral spinal reflexes acting on the flexor muscles of the hind-limb. The contraction evoked by reflexes exciting the same muscle when they are concurrent falls largely below the sum of the individual effects which they exert when apart. The effect of one of a pair of concurrent reflexes may default totally, i.e. be totally occluded. Such 'occluding' interaction is quite different from the inhibitory interaction of 'antagonistic' reflexes. Its explanation seems to be that, at some structure impinged upon in common by the 'allied' reflexes, (1) tetanic activation from one source precludes concurrent activation by a second, and (2) is not disturbed by the convergent activity of a second. The occlusion is a measure of the convergent overlap of 'allied' reflexes upon 'motor units' held in common. The occluded contraction emerges from occlusion without pause and step for step as the occluding activation subsides. Each individual afferent excites a reflex contraction which is of a pattern specific to that particular afferent.

R. J. Ludford: The Golgi apparatus in the cells of tissue cultures. The Golgi apparatus in the cells of tissue cultures undergoes a change in form with the spreading out of the cells on the surface of the cover-glass. It may be stretched until it fragments and its individual particles become dispersed in the cytoplasm; in other cells the osmophil substance of the Golgi apparatus becomes spread in the form of rodlets and granules upon a less deeply impregnated material (the idiosome, or sphere substance), and both substances become scattered together in the cytoplasm. Certain of the fatty globules in the cells of tissue cultures are considered to arise in relationship with the Golgi apparatus.

C. E. Walker and Margaret Allen: The nature of Golgi bodies and other cytoplasmic structures appearing in fixed material. If lecithin and kaphalin are added to colloidal mixtures and films or drops fixed without using acetic acid, structures exactly resembling Golgi elements, etc., are produced. Mitochondria, etc., are also represented. These structures also do not appear if acetic acid is used in the fixative. These artificial structures behave in the same way as Golgi apparatus, etc., when treated with osmic acid and when washed with turpentine. On adding oleaginous emulsions to the colloidal mixtures the structures produced by fixation and osmication appear to behave in a similar manner in relation to the globules of the emulsion as do Golgi elements, etc., to the nucleus of the cell.

W. S. Patton and E. Hindle: The development of Chinese leishmania in *Phlebotomus major* var. *Chinensis* and *P. sergenti*, var. (See NATURE, Mar. 26, p. 460.)

G. S. Sansom: The giant cells in the placenta of the rabbit. Two kinds of giant cells are found in the uterus. The larger are derived from the fetal trophoblast. They rapidly attain an enormous size, persist until about the 22nd day, and then break up into smaller bodies. Large numbers of these cells are also formed from a portion of the trophoblast which projects free into the uterine cavity after the attachment of the blastocyst to the placental folds on the 8th day. The cells proliferated from this 'trophoblastic fringe' pass into the uterine cavity and penetrate the regenerated uterine epithelium. The mesometrial giant cells are of maternal origin. Appearing about the 11th day and persisting until after the 27th day, they never attain great size. The

trophoblast of the chorion l ave gives origin to great numbers of multinucleate spheres, which become free, and are inactive degenerate structures.

Linnean Society, Feb. 17.—Miss Eleanor Vachell: An unusual specimen of *Anagallis*. The plant was noticed in a newly constructed public park at Coldknapp, Barry, Glamorgan, in July 1926. It had eleven stems—seven bearing scarlet flowers and four bearing blue flowers. Two types, *A. arvensis* Linn. and *A. f emina* Mill., are apparently represented on the same plant.—Julian S. Huxley: On the relation between egg-weight and body-weight in birds. The analysis of Heinroth's data on the body-weight and egg-weight of 432 species of birds reveals certain points not brought out in his paper. For birds as a whole, the relative egg-weight decreases from 12.2 to 1.8 per cent. of body-weight as we pass from the class of lowest to that of highest body-weight. The relation between egg-weight (y) and body-weight (x) can best be expressed by an equation of the form $y = bx^k$, in which b is constant, but k gradually decreases with increasing body-weight. The limiting value of k appears to be 1.0 for low body-weights. The differences in relative egg-weight between different groups remain approximately constant throughout; but in the smaller members of a group of high mean body-size, relative egg-weight is increasing much more rapidly with increasing body-size than in birds of the same absolute size constituting the heavier members of a group of small mean body-size.—J. T. Cunningham: Natural ambicoloration and the production of pigment in flat-fishes. The coloration of the lower side in naturally ambicolourate specimens is not due to the action of light, but seems to be rather a mutation arising from some abnormal condition in the gametes and fertilised eggs.

EDINBURGH.

Royal Society, Mar. 14.—J. H. Ashworth: Distribution of anopheline mosquitoes in Scotland. Three species occur, as in England, namely, *A. maculipennis*, *A. bifurcatus*, and *A. plumbeus*. The first is known from only four localities in Scotland, *A. bifurcatus* from 36 localities—this being apparently the most abundant and widespread species—and *A. plumbeus* from eight localities, all in proximity to the east coast or to its estuaries, but except for the Clyde area the west is practically unexamined. The areas in which ague was common in the eighteenth century are unfortunately those in regard to which little or nothing is known of their mosquitoes; there is therefore no basis for a consideration of the present distribution of Anopheles in relation to the former distribution of ague. In the single recent case of indigenous malaria, the history of which points to infection having been acquired at Kirriemuir (Forfarshire) early in August 1919, the mosquito probably acquired the organism (*Plasmodium vivax*) from an infected soldier there.—A. D. Hobson: A study of the fertilisation membrane in the echinoderms. Confirmation is given of the view that the zona pellucida is unnecessary for the formation of the fertilisation membrane. Artificial activation of the eggs of *Asterias rubens* by isotonic solutions of various salts is accompanied by normal membrane formation and shows that a decrease in surface tension is unnecessary for this process. These eggs may be partially activated by sperm during the earliest stages of maturation and show formation of Seifriz's 'protoplasmic papill e.' Fertilisations of eggs of *Echinus miliaris* were made in media of varying pH and salinity. Under these conditions, elevation of the membrane is caused by the presence of proteins beneath it; the membrane is completely permeable

to salts but impermeable to colloids from the time of its first appearance.—W. L. Calderwood: Salmon of the River Grand Cascapedia, Canada. Scale examination of a sample of 182 fish from this river shows that the early river life is retarded, the great majority of the fish descending to the sea when three years old. The high average of 23 lb. amongst the adult fish caught is accounted for by the absence of grilse and small spring fish. No grilse has ever been taken in the river. Three consecutive years' feeding in the sea is recorded on the scales of the great majority of the catch.

PARIS.

Academy of Sciences, Feb. 21.—Charles Moureu, Charles Dufraisse, and Ren   Chaux: Autoxidation and anti-oxygen action (xxi.). Experiments at higher temperatures. Application to the problem of the mode of action of the antidetonants. Details of the experimental study of the rate of oxidation by gaseous oxygen at 100   C. of paraffin wax, petroleum, naphthalene, tetrahydronaphthalene, decahydronaphthalene, some animal and vegetable oils. The effect of the addition of various catalysts in slowing down or accelerating the oxidation has also been studied. Starting with the conception that detonation in internal combustion engines (knocking) is due to the formation of peroxides in the liquid phase, a new theory of the action of antidetonants is developed.—Pierre Weiss: The atomic moment in complexes of the iron group.—Henri Villat: An extension of the method of Oseen.—W. Slobodzinski: The quadrics of Riemann space of three dimensions.—Paul Alexandroff: The decomposition of space by closed ensembles.—Paul Mentr  : Certain displacements of a quadric in ruled projective space.—Georges Bouligand: Potential and some connected theories.—Andr   Roussel: Equally continued functions.—Paul Flamant: The development of a linear transformation in a series of powers of the derivative and the extension of a distributive transformation.—Florin Vasilescu: The limit values of harmonic functions.—Gr. Fichtenholz: The integration of suites of summable functions.—Th. De Donder: The relativistic quantification of continued systems.—Henri Gutton and Jean Cl  ment: The dielectric properties of ionised gases.—G. Fo  x and Mlle. A. Brunet: The magnetic properties of manganese pyrophosphate at various temperatures; measurement of the moment of the Mn   ion. Manganese pyrophosphate follows the law of Weiss exactly over the temperature range, -80   C. to +485   C. The atomic moment of the Mn   ion is found to be 30 magnetons.—Nicolas Perrakis: The constant paramagnetism of pentavalent vanadium; V  O  , both in the solid state and in solution, has constant paramagnetism 64.4×10^{-6} .—Albert P  rard: Metrological researches on some neon and helium lines.—C. V. Raman and K. S. Krishnan: The constant of magnetic double refraction of benzene. On the basis of some simple hypotheses on the structure of the benzene molecule and on the optical anisotropy of the same molecule, the value of the Cotton-Mouton constant can be calculated.—A. Piccard and E. Stahel: The ether wind. Reply to a criticism of E. Brylinski.—R. Descamps: The anomalous rotatory dispersion in the ultra-violet of three aqueous solutions of tartaric acid containing boric acid. With the aid of a photographic spectropolarimeter, measurements of the rotatory power of tartaric acid solutions containing boric acid for wave-lengths varying from $\lambda 5780$ to $\lambda 2537$ were made. Contrary to the conclusions of Lowry and Martin, it is found that the $1/[\alpha]$, λ^2 diagrams are not straight lines, and the curves of rotatory dispersion appear to belong to the anomalous complex type in Lowry's classification.—J. Errera:

The specific inductive capacity of heterogeneous mixtures.—Charles Prévost: Some derivatives of 1.3.5-hexatriene.—Lespiau: True doubly acetylenic linear hydrocarbons, $C_{13}H_{20}$, and $C_{20}H_{34}$. Details are given of the preparation and properties of $CH:C-(CH_2)_9-C:CH$ and $CH:C-(CH_2)_{16}-C:CH$.—Maurice Delaville: Comparative migratory aptitude of the phenyl and diphenyl groups.—P. Nottin: Study of the deposit of starch on the tables of starch factories. It is shown that the conditions realised in the industrial preparation of starch are such that a large proportion of the smaller granules is lost in the waste liquors. An improvement is to be expected if the tables are not inclined.—Mlle. V. Malychef: The podzolic soils of the north-west of Tunis.—G. Ollivier: The tetrasporangia of *Falkenbergia Doubletni*.—Pierre Dangeard: The nucleus and nuclear evolution in the *Bangia*.—H. Vignes and Coisset: Calcium and halogen contents of the organism in the course of gestation.—H. Labbé and A. Kotzareff: The action of radium emanation on glycæmia in white mice.—Maurice Azéma: The accumulation of fatty reserves by the kidney of *Ascidia mentula*.—J. Chaîne: The progressive loss of the posterior insertions of certain cephalic muscles.—E. Derrien: Porphyrins and parasite worms. The use of Wood's light for the detection of parasites in meat.—E. Kohn-Abrest: The estimation on the spot of traces of nitrogen peroxide in air.—Léon Blum and D. Brown: The pathology of uræmia.

GENEVA.

Physical and Natural History Society, Feb. 3.—W. H. Schopfer: General results on the molecular concentration of the liquids of parasites. The molecular concentration of the parasites depends on that of the medium. There is constant adaptation to a medium the choice of which is caused by other physico-chemical factors still unknown.—L. Duparc: The tectonic of Abyssinia. The Abyssinian plateau has undergone an epigenetic movement in steps from the Trias to the Tertiary, with a steady withdrawal of the sea towards the east. A subsidence of recent date has opened a depression (Aouache valley) communicating with the great lakes and with the sea.—Ed. Claparède: The greatness of Pestalozzi and its numerical evaluation. If seven contemporary works on pedagogy are arbitrarily chosen the number of pages devoted to Pestalozzi, Rousseau, Herbart, Froebel, Comenius, Locke, Kant, Fénelon, Luther, Rollin, Montaigne, Erasmus, Basedow, Rabelais, the following percentages are found: 24.6, 13.4, 11.8, 9.2, 8.8, 5.8, 4.6, 3.9, 3.8, 3.5, 2.9, 2.9, 2.7, 2.—Sw. Posternak: The phosphorus-containing nucleus of milk casein. The nucleus of milk casein containing phosphorus, a proteid elaborated by the maternal organism for the phosphorus nutrition of the young animal, is formed of four serin phosphoric acids.—Em. Cherbuliez: The destruction of organic matter with the aid of perchloric acid. The destruction of organic material by oxidation is easily effected, without the intervention of non-volatile substances, with strong sulphuric acid to which has been added some perchloric acid containing a little fuming nitric acid.—G. Tiercy: The ionisation of gases and the temperatures of the stars. If, applying the formula of M. Saha and of Nernst, in which according to the author it is necessary to correct the constant (Saha's formula), the temperatures of the stars are calculated, the figures found agree remarkably well with those of H. N. Russell.

MELBOURNE.

Royal Society of Victoria, Dec. 16.—Gerald F. Hill: Termites (Isoptera) from South Sea and Torres Strait

Islands. These termites were collected by A. M. Lea in 1924. Of five species representing three genera, obtained in Fiji, two are proposed as new and three are referred to species originally described from Samoa. A number of immature *Calotermes* from New Caledonia are most probably referable to species previously described from this locality. The above appear to be the first records of termites from Fiji, Rennel, and Murray Islands.—F. Chapman: A Silurian jellyfish. This new species of a well-preserved jellyfish, *Discophyllum mirabile*, from the Silurian (Melbournian) beds at Brunswick, Melbourne, is closely related to *D. peltatum* J. Hall sp. from the Hudson River series below Troy, N.Y. The Melbourne fossil has a probable diameter of $6\frac{1}{2}$ in. It shows the radial and concentric frills of the umbrella, four gastro-genital pouches and extended tentacles. Both forms were fringed Scyphozoa. In associated strata in which the jellyfish was found there was a well-preserved example of *Bythotrephes gracilis* J. Hall sp. which shows the outer cellular layer of the plant.—F. Chapman: On a Limestone containing Lepidocyclina and other Foraminifera, from the Cape Range, Exmouth Gulf, Western Australia. The white limestones and chalky beds of this range, discovered by Dr. F. G. Clapp, belong to the older Lepidocyclina series, characterised by *L. dilatata*, a form hitherto unknown in Australian Tertiary deposits. 67 species of foraminifera are recorded, including one new species, *Bolivina spiroplectiformis*, and two species of Ostracoda, *Aglais clavata* G.S.B. and *Cythere lactea* G.S.B., both of which range through the Tertiary in Australia and are found living around the coast. It is concluded that the limestone is of Aquitanian age.—Z. A. Merfield: Total solar eclipse of May 9, 1929. On May 9, 1929, a total solar eclipse will take place and will be visible from northern Sumatra, Malaya, and south Cochin China. This is the only eclipse in the next twelve years to exceed 150 sec. duration. The duration on the west coast of Sumatra will be 5 min. 6 sec., and will afford a splendid opportunity for solar research. A series of meteorological observations has been organised by the Solar Eclipse Circle of the Solar Physics Commission of the International Astronomical Union, and will be made available in due course.—Z. A. Merfield: Solar radiation in the Lyman region. From observations made at the total solar eclipse of Jan. 14, 1926, with a moving plate anastigmat grating spectrograph, it is found that Na reaches a height of 3300 km., Ca 1500 km., Ca^+ 10,000 km., Ba^+ 1400 km. Similar results were obtained in Australia in 1922. When the ionisation potentials are taken into account, a comparison of the heights leads to the conclusion that stripped or ionised sodium is not supported by radiation pressure, and as a corollary, that solar radiation is deficient in the Lyman and far ultra-violet regions. The intensity of bright line emission in the far ultra-violet due to highly ionised atoms (taking Ca^+ as a typical example) depends on a mobile equilibrium and, as a result, radiation from this source is also weak. Solar radiation in this region of the spectrum does not appear to play any important part in the ionisation of the earth's upper atmosphere.—F. Erasmus Wilson: New Australian Coleoptera, with notes on some previously described species, Part iii. This paper deals mostly with minute beetles belonging to the family Pselaphidae, of which thirteen species are described, belonging to the following genera: *Schistodactylus* (1), *Narcodes* (2), *Schaufussia* (1), *Pselaphus* (6), *Tyromorphus* (2), and *Tinesipharus* (1). A species of *Daulotypus* belonging to the family Endomychidae and a species of *Technessa* of the family Oedemeridae are also described as new.

Official Publications Received.

BRITISH.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 7: The Igneous Geology of Ardsheal Hill, Argyllshire. By Frederick Walker. Pp. 147-157+1 plate. 1s. 9d. Vol. 55, Part 1, No. 8: On a Tetracotyle in the Brain of the Minnow. By Prof. J. H. Ashworth and Janet C. W. Bannerman. Pp. 159-172+1 plate. 2s. Vol. 55, Part 1, No. 9: A Critical Examination of the Vittarieae with a View to their Systematic Comparison. By Dr. S. Williams. Pp. 173-217+3 plates. 6s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Committee on Education and Industry in Scotland. First Report. Pp. 32. (London: H.M. Stationery Office.) 1s. net.

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 1, No. 4: The Evaporation of Water and Salt Solutions from Surfaces of Stone, Brick and Mortar. By Principal A. F. Laurie and John Milne. Pp. 62-68+1 plate. 1s. 6d. Vol. 47, Part 1, No. 5: The Distribution of Intensity in the X-ray Spectra of the Normal Saturated Dicarboxylic Acids, their Diethyl, and Mono-Ethyl Esters. By Alexander R. Normand, John D. Ross and Edward Henderson. Pp. 69-80. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Department of Agriculture, Jamaica. Entomological Circular No. 12: Insecticides and Fungicides. By C. C. Gowdey. Pp. 12. (Jamaica: Government Printing Office, Kingston.)

Brighter Biochemistry: being the Illustrated Journal of the Biochemical Laboratory, Cambridge, No. 4, February. Pp. 46. (Cambridge: Sir William Dunn Institute.) 2s. 6d.

Proceedings of the Royal Physical Society for the Promotion of Zoology and other Branches of Natural History, Session 1925-26. Vol. 21, Part 2. Pp. 33-108. (Edinburgh: Oliver and Boyd.) 7s. 6d.

The Solar Eclipse of 1927: Catalogue of Books on Astronomy in the Wigan Public Libraries; together with a Note on the Total Eclipse of the Sun to take place on Wednesday, June 29th, 1927, and a Map showing the Area of West Lancashire under the Shadow. Compiled by Arthur John Hawkes. Pp. 14. (Wigan: Central Public Library.) 3d.

Journal of the Chemical Society: containing Papers communicated to the Society. February. Pp. iv+iv+281-581. (London: Gurney and Jackson.)

Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. 3, No. 7: Experiments on the Treatment of Hookworm Infection in Dogs. By Amarnath Gulati. Pp. 167-185. 11 annas; 1s. 3d. Veterinary Series, Vol. 3, Nos. 8, 9: On the Occurrence of a Lung Fluke *Paragonimus edwardsi*, n. sp., in a Palm Civet (*Paradoxurus grayi*) in Kumaon Hills, by Amarnath Gulati; On the Occurrence of *Isospora* and *Balanitidum* in Cattle, by Hugh Cooper and Amarnath Gulati. Pp. 187-193+2 plates. 4 annas; 6d. Chemical Series, Vol. 3, No. 12: A Study of Absorption of Moisture by Soils. By Dr. Jatindra Nath Sen and Bhaial Motibhai Amin. Pp. 235-253. 6 annas; 9d. Chemical Series, Vol. 9, No. 1: The Selection of Baima Beans (*Phaseolus lunatus*) for Low Prussic Acid Content. By J. Charlton. Pp. 36. 10 annas; 1s. Chemical Series, Vol. 9, No. 2: Bangalore Maintenance Experiments, First Series. By F. J. Wirth. Pp. 37-61. 11 annas; 1s. 2d. (Calcutta: Government of India Central Publication Branch.)

The Journal of the Indian Mathematical Society. Edited by M. T. Naraniengar. Vol. 16, No. 12, December. Pp. 205-292+177-192. (Madras.) 1 rupee.

Journal of the Indian Institute of Science. Vol. 9A, Part 7: Reactions of Chromates at High Temperatures. Part ii: The System $\text{CaO-Cr}_2\text{O}_3\text{-O}_2$. By K. S. Nargund and H. E. Watson. Pp. 149-167. 1 rupee. Vol. 9A, Part 8: i. The Catalytic Hydrogenation of Carone, by Subinania Narayana Iyer and John Lionel Simonsen; ii. Conesine, by Darab Dinsha Kanga, Panchandana Ramaswami Ayyar and John Lionel Simonsen. Pp. 169-177. 8 annas. (Bangalore.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 12, Part 1: Contributions to our Knowledge of the Dermaptera and Orthoptera of the Transvaal and Natal. By James A. G. Rehn. Part ii: Mantidae. Pp. 54+2 plates. (Cambridge: Printed at the University Press.)

The Welsh Journal of Agriculture: the Journal of the Welsh Agricultural Education Conference. Vol. 3. Pp. 337. (Cardiff: University of Wales Press Board.) 2s. 6d.

The Botanic Gardens, Singapore. Illustrated Guide. Pp. 67. (Singapore.) 1 dollar; 2s. 4d.

Ministry of Health. Report of the Departmental Committee on the Treatment of Flu with Chemical Substances. Pp. 24. (London: H.M. Stationery Office.) 6d. net.

Quarterly Journal of the Royal Meteorological Society. Edited by a Committee of the Council. Vol. 53, No. 221, January. Pp. 98. (London: Edward Stanford, Ltd.) 7s. 6d.

FOREIGN.

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 530: Surface Water Supply of the United States, 1921. Part 10: The Great Basin. Pp. v+194+2 plates. 25 cents. Water-Supply Paper 555: Surface Water Supply of Hawaii, July 1, 1921, to June 30, 1922. Pp. iv+177. 30 cents. Water-Supply Paper 564: Surface Water Supply of the United States, 1923. Part 4: St. Lawrence River Basin. Pp. iv+171+8 plates. 25 cents. Water-Supply Paper 592: Surface Water Supply of the United States, 1924. Part 12: North Pacific Slope Drainage Basins. A: Pacific Basins in Washington and Upper Columbia River Basin. Pp. v+178+3 plates. 20 cents. Bulletin 768-A: Topographic Instructions v+178+3 plates. 20 cents. Bulletin 768-A: Administration. Compiled by H. M. Fryer. Pp. v+45. 10 cents. Professional Paper 137: The Fauna of the Ripley Formation on Coon Creek, Tennessee. By Bruce Wade. Pp. ii+272+73 plates. 1 dollar. Professional Paper 147-C: American Tertiary Mollusks of the Genus *Clementia*. By W. P. Woodruff. (Shorter Contributions to General Geology, 1926.) Pp. ii+25-49+plates 14-17. (Washington, D.C.: Government Printing Office.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1926. Pp. vi+375+5 plates. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution: United States National Museum. Bulletin 137: The Collection of Primitive Weapons and Armor of the Philippine Islands in the United States National Museum. By Herbert W. Krieger. Pp. iii+128+21 plates. (Washington, D.C.: Government Printing Office.) Jahrbucher der Zentralanstalt fur Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1922. Neue Folge, Band 69. Pp. xvi+A30+B39+C42+D8. (Wien: Gerold und Ko.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isorholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1926. Pp. 34+5 maps. (København: G. E. C. Gad.)

Proceedings of the United States National Museum. Vol. 63, Art. 19: *Kentriodon pernix*, a Miocene Porpoise from Maryland. By Remington Kellogg. (No. 2645.) Pp. 55+14 plates. (Washington, D.C.: Government Printing Office.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 78, 1926, Supplement: Synopsis of North American Diatomaceae. Part i: Coscinodiscatae, Rhizosolenatae, Biddulphiatae, Fragilariatae. By Charles S. Boyer. Pp. 228. (Philadelphia, Pa.)

Proceedings of the Imperial Academy. Vol. 2, No. 10, December 1926. Pp. xxvii-xxviii+521-564+ix+ii. (Ueno Park, Tokyo.)

State of California: Fish and Game Commission. Twenty-ninth Biennial Report for the Years 1924-1926. Pp. 127. (Sacramento, Cal.)

Bernice P. Bishop Museum. Bulletin 29: Ancient Hawaiian Music. By Helen H. Roberts. Pp. 401+5 plates. Bulletin 30: Pyroclastic Geology of Oahu. By Chester K. Wentworth. Pp. iv+121+22 plates. Bulletin 31: Insects of Hawaii, Johnston Island and Wake Island. By E. H. Bryan, Jr., and collaborators. (Tanager Expedition, Publication No. 3.) Pp. 94. Bulletin 32: History and Traditions of Nune. By Edwin M. Loeb. Pp. iv+226+18 plates. Bulletin 33: The Products and Structure of Kilauea. By John B. Stone. Pp. 59+2 plates. Honolulu, Hawaii.)

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 65, No. 5. Pp. xv+381-385. (Philadelphia, Pa.)

Conference on the Future of the Smithsonian Institution, February 11, 1927. Pp. 40+7 plates. (Washington, D.C.: Smithsonian Institution.)

Reprint and Circular Series of the National Research Council. No. 72: A Bibliography of the Analysis and Measurement of Human Personality up to 1926. By Dr. Grace E. Manson. Pp. 59. 1 dollar. No. 73: List of Publications of the National Research Council and its Fellows and Partial List of Papers having their Origin in the Activities of its Committees to January 1, 1926. Pp. 70. 75 cents. No. 74: The Need for Scientific Research in the Fishing Industries. By Maurice Holland. Pp. 8. 15 cents. (Washington, D.C.: National Academy of Sciences.)

Bulletin of the National Research Council. Vol. 11, Part 2, No. 56: Transactions of the American Geophysical Union, Seventh Annual Meeting, April 29 and 30, 1926, Washington, D.C. Pp. 134. (Washington, D.C.: National Academy of Sciences.) 1.25 dollars.

Proceedings of the United States National Museum. Vol. 70, Art. 7: Notes on Cestode Parasites of Birds. By Edwin Linton. (No. 2656.) Pp. 73+15 plates. (Washington, D.C.: Government Printing Office.)

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 86: The Uredinales or Rusts of Connecticut and the other New England States. By Dr. Willis Roberts Hunt. (Public Document N° 47.) Pp. 198. 1 dollar. Bulletin No. 87: Catalogue of the Lichens of Connecticut. By Prof. Alexander William Evans and Rose Meyrowitz. (Public Document No. 47.) Pp. 56. 60 cents. (Hartford, Conn.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 384: Tides and Currents in South-east Alaska. By R. W. Woodworth and F. J. Haight. (Special Publication No. 127.) Pp. iv+149. (Washington, D.C.: Government Printing Office.) 25 cents.

Smithsonian Miscellaneous Collections. Vol. 78, No. 6: The Lyell and Freshfield Glaciers, Canadian Rocky Mountains, 1926. By Dr. J. Monro Thorington. (Publication 2911.) Pp. 8-12 plates. (Washington, D.C.: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 21: Record of Current Educational Publications; comprising Publications received by the Bureau of Education to October 1, 1926. Pp. 24. (Washington, D.C.: Government Printing Office.) 5 cents.

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Mauran. Tome 4. Pp. iv+163. (Paris: Les Presses universitaires de France.)

The Royal Colonial Institute at Amsterdam: Origin, Scope and Future. By C. J. Hasselman. Translated from the Dutch by E. J. Labarre. Second, revised edition. Pp. 104. (Amsterdam.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 311: Stucco Investigations at the Bureau of Standards, with Recommendations for Portland Cement Stucco Construction. Pp. 34. (Washington, D.C.: Government Printing Office.) 15 cents.

Diary of Societies.

SATURDAY, APRIL 2.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Bradford), at 2.

INSTITUTION OF BRITISH FOUNDRYMEN (Lancashire Branch) (Annual General Meeting) (at College of Technology, Manchester), at 3.—At 4. —B. Hird: Absorbed Gases in Iron and the Creation of Gas Holes in the Casting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (3).

MONDAY, APRIL 4.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr. S. M. Zwemer: The Place of Woman in Islam.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration of Large Intestine.
SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—G. C. Workman: Some Aspects of Reinforced Concrete.
INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—W. G. Ruggins: Automobile Repairs.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.
SOCIETY OF CHEMICAL INDUSTRY (London Section, jointly with Fuel Section) (at Chemical Society), at 8.—Dr. R. Lessing: The International Conference on Bituminous Coals at Pittsburgh.

TUESDAY, APRIL 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. W. Cobb: Some Properties of Coke (2).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—E. G. Boulenger: Exhibition of Photograph of a Crab with Abnormal Claw.—Dr. J. Beattie: The Anatomy of the Marmoset, *Hapale jacchus* Linn.—Dr. H. H. Woollard: On the Brain of the Marmoset, *Hapale jacchus* Linn.—Major R. W. G. Hingston: Protective Devices in Spiders' Snares.

INSTITUTION OF CIVIL ENGINEERS, at 6.—I. J. Jones and G. Curry: The Enlargement of the City and South London Railway Tunnels.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—R. Green: Bird Portraiture.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester) (Annual General Meeting), at 7.—F. H. Clough: The Stability of Large Power Systems.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. Barford: Pictures from the Pyrenees.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at University, Birmingham), at 7.15.—A. A. King: Ultraviolet Light.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—A. P. Young and L. Griffiths: The High-Tension Magneto, with Special Reference to its Design, Manufacture, and Service.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—J. V. Sparks: Uses of Lipiodol as an Aid to Diagnosis in Diseases of the Chest.—F. Melville: X-Ray Cinematography.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Dr. C. Singer: Tradition and Observation as illustrated by the Herbal 100 B.C. to 1500 A.D.

WEDNESDAY, APRIL 6.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. H. L. Hawkins and Miss S. M. Hampton: The Occurrence, Morphology, and Affinities of the Silurian Echinoidea Echinocystis and Palaeodiscus.—V. G. Glenday and Dr. J. Parkinson: The Kaleruk Series and Associated Rocks of the Northern Suk Hills (Kenya Colony).

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—F. E. Wentworth-Shields: Methods of Preserving Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—P. R. Coursey and H. Andrewes: Battery Eliminators or Appliances for the Operation of Radio Receiving Apparatus by Energy Derived from Electric Supply Mains.

INSTITUTION OF SANITARY ENGINEERS (at Caxton Hall, Westminster), at 6.—R. C. N. Newport and E. O. Danger: Kingsbury Main Drainage Scheme, 1924-1925.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—T. Settle: Women's Place in the American Electrical Industry.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—W. W. Bath: A Modern Power Station.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—C. Ainsworth Mitchell and T. J. Ward: The Sequence of Strokes in Writing.—Dr. D. W. Kent Jones and C. W. Herd: (a) Some Observations on the Wasting of Gluten from Flour; (b) A Numerical Expression for the Colour of Flour.—Dr. H. B. Dunscliff and Kishen Lal: The Determination of Free Mercury in Commercial Products.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF MEDICINE (Odontology and Study of Disease in Children Sections), at 8.—A. T. Pitts (Odontology), Dr. R. Hutchison (Disease in Children), and others: Discussion on Oral Manifestations of General Disease in Children.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section) (Laboratory Meeting at London School of Hygiene and Tropical Medicine), at 8.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts).—Annual General Meeting.

THURSDAY, APRIL 7.

LINNEAN SOCIETY OF LONDON, at 5.—G. C. Robson: Exhibition of Preparations and Lantern-slides illustrating Bacterial Luminescence in Cephalopoda.—Prof. J. Percival: The Species and Races of Wheat and their Relationships.

ROYAL SOCIETY OF MEDICINE, at 5.—W. G. Spencer, Dr. H. French, Dr. Fortescue Fox, and others: Discussion on Blood-letting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—H. J. E. Peake: The Beginnings and Early Spread of Agriculture (2).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce: A Contribution to the Study of the Number of Tests required to establish the Rupturing Capacity of an Oil Circuit-Breaker.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. C. V. Raman: Huygens' Principle and the Phenomena of Total Reflection.—H. W. Lee: The Hartmann Formula for the Dispersion of Optical Glass.

CHEMICAL SOCIETY, at 8.—H. King: Trypanocidal Action and Chemical Constitution. Part VI. Amphoteric *s*-carbamidoylarsinic Acids.—E. J. B. Willey: On Active Nitrogen. Part III. Active Nitrogen and the Metals.

HARVEIAN SOCIETY OF LONDON (at Paddington Town Hall), at 8.30.—T. P. Dunhill, Dr. C. M. Wilson, and others: Discussion on the Treatment of Graves' Disease.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts).—Annual General Meeting.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, APRIL 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. E. W. Brown: Note on Dr. Fotheringham's Paper entitled "Trepidation"—P. A. Curry: The Effect of reversing a small Transit Instrument.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of the Anatomy and Physiology of the Cecum and Appendix Vermiformis.

MALACOLOGICAL SOCIETY (at Linnean Society), at 6.

WOMEN'S ENGINEERING SOCIETY, at 6.30.—Miss E. M. Kennedy: A Business Woman's Trip to America.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. Ambrose: Electrical Osmosis.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—E. A. Smith: Refined Silver for Electro-plating Anodes.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Prof. S. Russ and Miss G. M. Scott: (a) The Growth of Tumours in Tissues Exposed to X-rays and Radium; (b) The Action of Radon Seeds upon Tumours and Some Normal Tissues of the Rat.—Dr. J. C. Mottram: On the Co-relation between the Experimental and Clinical Radiation of Tumours.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Early Days in Radio-activity.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts).—Annual General Meeting.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section).—Annual General Meeting.

SATURDAY, APRIL 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (4).

PUBLIC LECTURES.

SUNDAY, APRIL 3.

GUILDHOUSE (Eccleston Square), at 3.30.—Prof. J. P. Bruce: Con-fucianism.

THURSDAY, APRIL 7.

FULHAM CENTRAL PUBLIC LIBRARY, at 8.—J. Weathers: Some Common Mistakes in Gardening.

SUNDAY, APRIL 10.

GUILDHOUSE (Eccleston Square), at 3.30.—Rev. Father Andrew: Christianity.

COMMEMORATION.

LISTER CENTENARY, APRIL 4, 5, AND 6.

April 4, at 3.—King's College Hospital.—Sir Watson Cheyne, Bart., Sir Lenthal Cheate, and others: Lister's Personality.—At 8.30.—Royal Society of Medicine.—Sir StClair Thomson: The Centenary of Lister, Personal Recollections by One of his House-surgeons.

April 5 (at British Medical Association, 19 Tavistock Square, W.C.), at 11.30 A.M.—Reception of Delegates by the Prime Minister.—At 4.—Conversazione at Royal College of Surgeons of England.

April 6 (Westminster Abbey), at 11.15.—Bishop of Birmingham: Address.—(At Royal Society of Medicine, 1 Wimpole Street, W.), at 3.—Discourses by Sir Charles Sherrington, Prof. W. Bulloch, and Sir Berkeley Moynihan, Bart., on Lord Lister as Physiologist, Bacteriologist, and Surgeon.—At 9.—Conversazione at Royal Society.

CONFERENCES.

APRIL 7 TO 9.

TUBERCULOSIS SOCIETY AND SOCIETY OF SUPERINTENDENTS OF TUBERCULOSIS INSTITUTIONS (at Oxford).

April 7, at 2.30.—Prof. L. Cunningham: The Bovine Tubercle Bacillus in Immunisation.

April 8, at 10 A.M.—Dr. Leonard Hill and others: Discussion on the Defensive Mechanism of the Body against Tuberculosis from the Physical and Chemical Aspect.—At 2.15.—Dr. J. Freeman: The Defence of the Body from the Bacteriological and Immunological Side.—Dr. A. G. Gibson: Secondary Infections in Relation to the Progress of Pulmonary Tuberculosis.—Dr. A. D. Gardner: The Laboratory Diagnosis of Tubercle.

April 9, at 10 A.M.—Dr. J. M. Martin, Dr. D. P. Sutherland, and Dr. P. Edwards: The Gaps and Flaws in the Public Health Administration of Tuberculosis.

APRIL 20 TO 24.

JOURNÉES MÉDICALES MARSEILLAISES ET COLONIALES (at Marseilles).—Prof. Cantacuzène: The Role of the *Streptococcus* in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann: Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.



SATURDAY, APRIL 9, 1927.

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No. 2997, VOL. 119]

Technical Education and Industry.

IF any apology were needed for our return to the third volume published by the Committee on Industry and Trade,¹ we would refer our readers to the articles and reports dealing with education and industry which have appeared in our columns during the last two years or so. If those articles and reports be carefully scrutinised, it will be seen that we have attempted, very deliberately, to show not only the necessity, but also the origins, directions, and even deflexions of the rapidly growing tendencies towards a scientific view of education in relation to the structure of modern society. We venture to suggest, too, that our interpretation of the term 'scientific education' has been wide and liberal enough to satisfy the most suspicious guardian of the delectably elusive qualities which are covered by the word 'culture.' Perhaps at another time we shall demonstrate the possibility of realising some of the classical ideals which are still inherent in the life of a community developing under an apparently grey and formless industrialism. In the meantime, the attitude of the present volume towards technical education has a special attraction from the point of view of its significance to the educational movements we have been observing.

Whatever may be our notions of the contributions which are made towards the solution of the problems before the Committee, we believe that its attitude towards the relationship of technical education to industry will do much to strengthen that relationship, and so aid, not only in the industrial reconstruction which lies ahead, but also in the general intellectual progress towards a less anomalous civilisation than exists at present.

It would be easy, perhaps, to criticise the chapter on technical education on certain grounds, the chief of which might be that it is based upon memoranda supplied by government education departments, and that it presents the usual shortcomings of memoranda from such sources, namely, a certain timidity and a platitudinous repetition of possible improvements. But it must not be forgotten that what is platitudinous to the expert may be illuminating and inspiring to the layman; and this volume is primarily for business men rather than for educationists. The charge of timidity, too, loses much of its power when we read the Committee's warning that the volume "is not concerned

¹ Committee on Industry and Trade. Factors in Industrial and Commercial Efficiency, being Part I. of a Survey of Industries. With an Introduction by the Committee. Pp. v+544. (London: H.M. Stationery Office, 1927.) 5s. net.

with recommendations. Its aim is to assemble and analyse facts and tendencies, and by so doing to narrow the range of economic controversy and prepare the way for the intelligent study of the problems by which British industry is confronted."

Three necessities are, however, made clear: expansion of the scope and number of technical classes; the better adjustment of their relationship with industry; and the constant need to adjust the relations of general and technical education.

Further, if the Committee does not profess to give detailed recommendations, its survey of the present relationship of technical education to particular industries, and its suggestions as to possible improvements, will be greatly helpful to any national industrial organisation, group of employers, or individual employers. Clearly the Committee is doubtful whether full co-operation can be reached by local advisory committees alone. It realises that as yet there has been little serious study on the side of industry of the possibilities of a considered policy of technical school training for young employees; and it is certain that substantial improvements could be suggested if each industry would survey, from its own point of view, the existing facilities, see what gaps need filling and what developments are desirable, take an active interest in the schools and give effective assistance to their conduct. That assistance could take many forms. Lectureships could be founded or subsidised where the public provision is inadequate; grants to part-time teachers to help them to gain wider experience or to improve qualifications; scholarships to promising students; consideration of the methods of filling the more responsible posts; consideration of the number of men needed annually, and the kind of qualifications they should possess; allowance of 'time-off' during working hours to students who have shown diligence and ability to profit by instruction in technical schools.

Three other serious weaknesses of the present system are indicated. The connexions between universities and technical schools are accidental rather than systematic, even though some technical institutions are of university rank and function as technical universities. Premises, too, are unsatisfactory, and work is sometimes conducted "under conditions which are tolerated rather than approved." Finally, the training of teachers presents a difficult problem. Obviously men of experience and skill in trades and processes they teach are essential. But more than such experience and skill is necessary if the highest results

are to be attained. Vacation courses have proved extremely valuable; but these, in themselves, are not sufficient. By what other means can this vital problem be settled?

The Committee's view of its problems is shown excellently in some passages which are worthy of reproduction:

"The vitality of modern industry, like that of an organism, is measured by its power of response to external stimulus and of self-adaptation to modern environment. Mobility (in this sense of the term) does not imply incessant and purposeless movement or change. . . . But it does imply the power of spontaneous reaction to changes in economic conditions and of internal modifications and rearrangement to meet such changes. . . . It applies to modes of preparation for industry and the right adjustment between the functions of school education and workshop training which demand continual modification and re-adaptation both to fit the changing needs of modern large-scale industry and to counteract some of the dangers of excessive sub-division of employments."

Following this line of thought, the Committee does not fail to observe that in our age of flux and transformation, no plan of educational development can be justified which does not maintain unimpaired initiative, flexibility of temperament, powers of adaptation and capacity for co-operation among all the partners in production and distribution. Such a view ought to show very clearly to those who may be fearful, that mere vocational instruction is by no means what the Committee understands by the term 'technical education.'

It would, after all, be too much to expect from a single committee—and particularly from a committee with such wide terms of reference—a solution of the delicate, far-reaching, and many-sided problems presented by an attempt to examine the relationship of technical education to industry. It must not be forgotten that other bodies are also making their contributions to these problems; and if we indicate only some of the activities which we have been observing, it will be sufficient to justify the remark we made above concerning "rapidly growing tendencies."

The Board of Education's Consultative Committee has presented its report on the education of the adolescent; a Committee on Education and Industry (under Mr. D. O. Malcolm) has presented the first part of its report, and is preparing the second part; a Ministry of Labour Inquiry into the general question of apprenticeship is not yet completed; the League of Nations recently held a conference on conciliation in industry, and will shortly continue that conference at Geneva;

finally, the committee brought into being by the many learned and professional institutions and teaching associations under the chairmanship of the late Lord Emmott, is now in the stages of compiling its report on the relationship of technical to other forms of education and to industry. When such activities are reviewed the importance of the present volume may be rightly judged, especially when it is recalled that the President of the Board of Education informed a deputation of the Emmott Committee, last May, that not until he had before him the reports of at least four of these bodies could he begin to formulate the changes which may be immediately necessary.

The contribution of the present volume, too, falls further into its place when we note that it divides its educational problem into three main parts: industrial output is not a mere question of volume, but depends essentially on quality; under modern industrial conditions the relative range and potency of apprenticeship have tended to diminish; school education before entering, and concurrently with, employment has increased in importance.

There is not yet any consensus of opinion, however, as to the mutual relations and limits of workshop training and school education, looked upon as complementary factors. In making its surveys of technical education and apprenticeship, the Committee hoped to be "of assistance in arriving at clearer views on this vitally important question." That the volume achieves that object is beyond all doubt.

Politics as a Science.

The Science and Method of Politics. By Prof. G. E. G. Catlin. Pp. xii + 360. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1927.) 12s. 6d. net.

THIS is an able and interesting volume, in which there is at once great learning and considerable power of speculation. Prof. Catlin has an important thesis to maintain, and his urbanity of manner will not conceal from the reader that he is prepared to maintain his ground against all comers. The field, indeed, is already, as if in advance of conflict, strewn with the illustrious dead; at least I seem to discern there the scalps of Plato and Aristotle, Kant and Hegel, exposed as a warning to prospective combatants.

In a sense, Prof. Catlin's book is difficult to review; for it is to be followed by a book already in preparation in which the thesis he here lays down is to be applied to our problems. Obviously,

therefore, we shall not fully know what the method he advocates can do until he himself has applied it; and conclusions upon his analysis must be provisional until he has given us the full opportunity to see it at work. But as I understand his views, his purpose is to construct a science of politics which shall seek to do for man in society what the early economists did for the phenomena they survey. It will be abstract and deductive; it will have its axioms and postulates; and the test of its validity will lie in the verifiability of its predictions. Such a science, he argues, must free itself from the shackles which the historian and the philosopher have sought to impose upon it. For values it will have no concern. It will be concerned only with the observed behaviour of men. Assuming that there is a political man with the appetite for power, it will seek to construct the laws of his behaviour in adjusting means to purpose. With right or wrong it will have no more concern than the chemist with the moral qualities of hydrogen. It will be quantitative in character in that, upon the basis of its assumptions, it will seek from observation the largest possible number of examples from which to draw its conclusions. Having made abstraction of ethics, it will be able to approach the facts without a *parti pris*; and, instead of offering futile sacrifices upon the altar of teleology, it will be able to say (p. 199) that the "social situation only admits of certain appropriate measures." For studying what men do, it will be able to tell us what they will do; between the two Prof. Catlin injects a formidable *therefore*; and as this science of politics is refreshed by the constant accumulation of facts about the behaviour of men in their desire for power, as, also, such sister sciences as psychology contribute their due quota of knowledge, we may hope for the discovery of truths which will have value and influence of the same magnitude as those to which the economists have given birth.

There is an air of promising certitude about these propositions, which have at least the merit of interesting audacity; though I observe with a little surprise that Machiavelli is appealed as their benevolent compurgator. For if ever a man had a definite end in view (which, as a passionate Italian patriot, he would have regarded as ethical), if ever, also, a man selected his facts to suit the thesis his experience dictated as best suited to his end, that man was Machiavelli. Perhaps the best thing one can do is to indicate, though with appreciation, some of the doubts to which Prof. Catlin's argument gives rise. The victories of

economic science as built in terms of 'economic man' seem to me less outstanding than he claims, and its main successes have been won in spite of, rather than because of, its original and rigorous abstraction. The chief influence of the late Prof. Marshall, for example, was mainly due to the ingenuity with which he transformed the classic economics into something approaching the complexity of the facts; in no other way, moreover, could the economists answer the challenge of Marx, whose own 'economic man' led, by the technique of his construction, to quite different conclusions.

Prof. Catlin, moreover, has a simple faith in facts as such, which, in the social sciences, at least, I do not find it easy to share. They are not born free and equal. The expert interpretation of a social environment is coloured by the personal equation of the observer in a way that is momentarily different from an expert interpretation of a physical or chemical environment. What Mr. Justice Holmes has called the 'inarticulate major premiss' of the judiciary is, as a rule, the main clue to their decisions; and yet the best of judges usually believe that they are finding the law in an unbiassed and scientific way. Nor is this all. The maxim 'as men behave, so they will behave,' is, statistically, probably true in a static world; the trouble with this world is that the environment changes at a pace so rapid that the forms of behaviour in one place or period are no clue to those forms in another. I agree that most social situations admit only of certain appropriate measures. But the difficulty here (and I cannot find that Prof. Catlin deals with it) is that the measures have to be chosen in terms of an end deemed right or wrong. We are, in fact, at once outside the realm of scientific politics; for here we are dealing with argument that has reference to ethical value which Prof. Catlin deems irrelevant. I would venture here to add that if the 'political man' were what he describes him to be, in any sense that can be called significant, he represents so small a proportion of mankind that prediction built upon his behaviour would be no clue to the general habits of men. I wish, indeed, that Prof. Catlin had given us some examples of the political 'laws' that his science would establish. Provisionally, at least, he still leaves me with the impression that Burke's 'little mirror of circumstances' would be vital in the battle.

Perhaps I may put my difficulty in terms of an analogy. The Common Law for long proceeded upon the assumption (akin in character to that of Prof. Catlin) that where there was no remedy there

could be no wrong; and in order that it might be adequate and effective it was necessary to invent the remedies of Equity, which proceeded upon the assumption (akin to that of political philosophy) that wrongs as such were entitled to redress. My own conviction is that Prof. Catlin's science of politics would need a similar supplement. What seems to me really valid (and brilliantly demonstrated) in his book is its plea for the systematic collection of facts and the deliberate undertaking of experiment. We need, in fact, an inductive study of politics, based on quantitative tabulation, instead of deductions moulded from our private desires. To have shown with wit and point and learning how much might be expected from such a development is the very considerable service Prof. Catlin has rendered us.

HAROLD J. LASKI.

Synthetic Organic Chemistry.

- (1) *The Synthesis of Benzene Derivatives*. By Stanley C. Bate. Pp. 229. (London: Ernest Benn, Ltd., 1926.) 21s. net.
- (2) *The Use of Solvents in Synthetic Organic Chemistry*. By Prof. Donald W. MacArdle. Pp. vii+217. (London: Chapman and Hall, Ltd., 1926.) 15s. net.
- (3) *Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals*. Editor-in-Chief: Carl Shipp Marvel. Vol. 5. Pp. vii+110. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 7s. 6d. net.

THE ever-growing output of research that marks the progress of chemical science is reflected in the increasing size of the chemical journals; and the task of the researcher whose text-books these form becomes more onerous each year. The work is lightened by the publication of the Chemical Society's Annual Reports, and by the appearance from time to time of monographs dealing with the more important theoretical aspects of the problems under investigation, but the wealth of information 'tied up' in the experimental work of the original papers is not so easily rendered accessible. This difficulty has been partially solved by the compilation of such comprehensive treatises as Houben-Weyl's "Die Methoden der organischen Chemie," or Meyer's "Analyse und Konstitutionsermittlung organischer Verbindungen," and the first two of the three books under review are frank attempts on the part of the authors to provide for English-

speaking chemists similar correlated information on definite problems connected with laboratory practice.

(1) Mr. Bate seeks to give in a short and concise form the various methods available for the synthesis of organic compounds that may be of utility both to senior students and research chemists, and the present pioneer volume is concerned with the synthesis of derivatives of benzene. The subject is discussed in twelve chapters, each dealing, usually, with one type of reaction. Thus in the chapter on nitro compounds, the nitration of different types of compounds by means of nitric acid is described; then follows a description of other methods of nitration; of the conversion of amines into nitro compounds; of anomalous cases occurring in nitration; and finally, the effect on certain groups of the presence of the nitro group in the molecule is discussed. The text contains full references to the original papers and patents up to April 1925, as in very few cases is sufficient detail supplied to make the reader independent of the original memoir. The reviewer suggests that in a future edition the names of the investigators be given as well as the references, in order to facilitate cross reference to abstract journals; and also, that the present scanty index be considerably extended.

The general arrangement of the book is excellent, the printing clear, and the text remarkably free from errors, but in a few cases confusion arises from the use of italics at the beginning of a paragraph for the introduction of a new main section, whilst a sub-section is placed under headlines in heavy type. Not a few formulæ are faulty owing to the misuse of the dot and bracket; and the printing of such expressions as "to react the substance," and "the substance to be amidated," and "oxy" for "hydroxy," are not pleasing to the English ear. These minor blemishes do not detract from the value of a book of such excellence that it should form a unique and most useful addition to the reference library of the organic chemistry departments of all university and technical institutions.

(2) Prof. MacArdle's book is the first part of a treatise on the operative technique of synthetic organic chemistry, similar in a general way to the first sections of the well-known German works of Lassar-Cohn and of Weyl. The first chapter is devoted to "General Considerations," and treats of solution, methods of bringing about solution, choice of solvent, interliquefaction, crystallisation, solvent of crystallisation, and mixed crystals. In the following seven chapters the uses of the various types of solvents are discussed, the question of the

purifying of the substance being treated critically and the fullest practical details being supplied. These chapters are rich in references to special cases in which the solvent in question has proved of unique value, and also of instances when anomalous reactions have occurred which limit the use of the solvent. The remaining two chapters are devoted to a consideration of "Special Means to Induce Crystallisation" and to "Salting Out"; a full bibliography and two exhaustive indexes are appended.

The arrangement of the book and the presentation of the subject leave nothing to be desired; for, in addition to its eminently practical value, the book is a readable one and holds the interest of the reader from the first page to the last.

The statement on page 138 that the dangers attending the use of dimethyl sulphate have been very much exaggerated cannot be generally endorsed, for in the experience of the reviewer more than one case of serious and prolonged indisposition has resulted from the use of this substance without special precautions being taken to remove all vapours in an effective draught.

(3) The last of the three books with which this review is concerned differs widely in scope and purpose from the others. It is the fifth volume of "An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals"; and indeed so eminently satisfactory are the methods described therein that the issue of the yearly volume marks a red-letter day in the organic laboratory. Since the publication of the first volume, when the editors invited the co-operation of other organic chemists, the response has become wider each year, and in this volume twenty-four of the thirty-three preparations have been submitted by eighteen contributors.

M. A. W.

The American Mongolian Expedition.

On the Trail of Ancient Man: a Narrative of the Field Work of the Central Asiatic Expeditions. By Dr. Roy Chapman Andrews. With an Introduction and a Chapter by Henry Fairfield Osborn. Pp. xxiv + 375 + 61 plates. (New York and London: G. P. Putnam's Sons, 1926.) 25s. net.

NORTH-EASTERN Asia has entered the field as one of the competitors with south-western Asia as the home of man. The discovery of some fossil vertebrates that are common to Europe and western America but are absent from eastern America led Prof. H. F. Osborn in 1900 to predict that these animals had developed in

northern Asia and thence migrated eastward into Europe and westward into America. The ocean they crossed was therefore the Pacific and not the Atlantic. Faith in this theory led Dr. R. C. Andrews to organise an expedition to search for the remains of these animals in the steppes which they must have crossed during their migration from inner Asia to the Rocky Mountains. The generosity of American patrons of science provided £50,000 for the purpose, and Dr. Andrews led to Mongolia a series of well-equipped expeditions which there made several sensational discoveries. The most dramatic was the finding of the eggs of Cretaceous dinosaurs. They were found in such abundance in one locality that one Mongolian woman brought in fragments of egg-shells in tinsuls. The eggs belong to three genera, one of which, *Protoceratops*, is a primitive form of the *Ceratopsidae*. Dr. Andrews describes this locality as a dinosaur incubator, and he attributes its selection as the breeding-ground to the nature of the sand, which would have formed comfortable nests.

Of still greater importance was the discovery, also in the Middle Cretaceous beds, of some mammal skulls. The first found had been sent to New York as a reptile, and recognised by Dr. W. D. Matthew as a primitive mammal. Stimulated by his report of the importance of the discovery, the search was renewed and other specimens found. A preliminary account of the skulls is given in the volume, but a more detailed account has been recently published elsewhere. The expedition also discovered a series of important Eocene mammals. The first of the vertebrate fossils found by the expedition were some bones of the *Baluchitherium*, an Oligocene mammal, which was discovered by Cooper in northern India. The expedition found later a skull and a skeleton of this mammal, and Dr. R. C. Andrews was led by the discovery to the expectation that, as the human family probably began to diverge from the ordinary primates in the Oligocene, the remains of some primitive ancestors of man should be found in Mongolia.

Large numbers of stone implements were found; they represent two periods—Neolithic and Upper Palæolithic. The age of the latter is suggested as Azilian. Some members of the expedition were at first under the impression that the rough stone cores represented a pre-Chellean culture; but ultimately they were convinced by the large series collected and arranged by the archaeologist, Mr. Nelson, that the cores were the residue of Upper Palæolithic flaking. Nothing human was obtained by the expedition earlier than the Mousterian, of

which implements have already been found in China, in the valley of the Hoang-ho. While the palæontologists were excavating the fossils, the two geologists with the expedition—Prof. Berkey and Mr. F. K. Morris—surveyed the area, worked out its history, and thus made a valuable contribution to Asiatic geology. Amongst other points of interest they find that there is no evidence of glaciation in the district, except in some small corries on the highest hills.

The volume tells the narrative of the expedition. It is graphically and racily written, and gives a delightful picture of a group of men in cordial co-operation and all enthusiastic in their work. Probably in the effort to be popular the author constantly states the age of the beds in years, reporting, for example, that the earlier implements date from 40 thousand, and the later from 15 thousand years ago; such estimates are about as useful as if a historian tried to date an Act of Parliament by reference to the birth of John Smith. The book is well illustrated by photographs showing the expedition at work and the nature of the country, and by ideal pictures of the fossils skipping about in their native haunts. J. W. GREGORY.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1925-1926, by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-third Annual Issue. Pp. vii + 399. (London: Charles Griffin and Co., Ltd., 1926.) 18s. net.

To those who have used this work of reference, the new issue requires no commendation. For those who have not yet handled it, emphasis may be laid on the words from the title-page: "Compiled from Official Sources." The information provided as to the titles, addresses, officers, and activities of the scientific and learned societies and Government institutions in Great Britain and Ireland has been obtained from officials of the societies concerned, so the volume serves as a directory. In addition, the lists of authors and titles of papers presented before each society during 1925 gives some indication of the amount and direction of progress made in science and the arts. Take, for example, the Royal Society: the total number of papers, 226, shows great activity in the scientific world, while the fact that nearly three-quarters of them were published in Series A of the *Transactions* or *Proceedings* testifies to the fertile field of the mathematical and physical sciences.

The various societies are grouped according to the subjects of their interests, beginning with those dealing with science generally. As regards

classification, there will obviously be differences of opinion; we think, however, that the Röntgen Society would be better in the Physics Section than under Chemistry and Photography, while the Spelæological Society (University of Bristol) is certainly archaeological rather than biological. The index, however, soon smooths out little difficulties of this kind. The new address of the British Cast Iron Research Association, at 24 St. Paul's Square, Birmingham, was probably announced too late for insertion. We are still of the opinion that all the research associations in Great Britain now in existence should be included and indexed under 'Research.' Some of the more recently formed scientific bodies have not yet appeared in the volume, but meanwhile we must be grateful for the valuable collection of data with which the publishers of this annual continue to supply us.

Elemente der exakten Erblchkeitslehre: mit Grundzügen der biologischen Variationsstatistik. Von Prof. Dr. W. Johannsen. Dritte deutsche, neubearbeitete Auflage in dreissig Vorlesungen. Pp. xi+736. (Jena: Gustav Fischer, 1926.) 32 gold marks.

THIS well-known book, which was first published in 1909, has now reached its third edition. It is still divided into thirty 'lectures,' but various additions and alterations have been made. More attention is paid to Sheppard's correction for class variants and to Bravais' formula for reckoning the coefficient of correlation. In the latter formula the value of every variant, and not merely that of the classes, enters into the result, and the method can also be used for alternative as well as quantitative variations. The chapters on selection have been extended and those on Mendelism re-written in the light of the more recent work. The word 'gen' is used throughout for the hereditary unit, and Bateson's term 'allelomorph' has been shortened to 'allele,' with a result which would not be very happy if the word were used in English form. In its present form the work will continue to be of great use to geneticists, since it gives in convenient form the various statistical methods used in genetical investigations. But more than this, it is a discussion from the author's characteristic point of view of large fields in experimental genetics.

R. R. G.

Prehistoric Man and the Cambridge Gravels. By the Rev. Frederick Smith. Pp. viii+121+30 plates. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1926.) 7s. 6d. net.

THE Rev. Frederick Smith, the author of a book on the Stone Ages in North Britain and Ireland, has been engaged in archaeological research for more than sixty years. He began to collect from the Cambridge gravels when he was a boy, and he returned to his old hunting-ground in 1924. He has collected many thousands of specimens, and the constant recurrence of certain forms has convinced him that his specimens are implements of various kinds—arrowheads, spear heads, hatchets, knives,

and flakers, piercers, and saws—and that certain of them were fitted with shafts. In addition he has found sculptures—a baboon, eagle's beak, an oyster shell, and so forth. The date attributed to them is pre-Chellean, Chellean, and Acheulean. Mr. Smith argues that though the early archaeologists were ridiculed and rejected, their views were afterwards accepted, and by analogy claims indulgence for his own views. The argument is as dangerous as its converse. Mr. Smith figures a number of the specimens which he maintains are implements, showing them with and without hafts, but his illustrations still fail to convince.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 199. Abt. 9: *Methoden zur Erforschung der Leistungen des tierischen Organismus*, Teil 4, Heft 2. *Methoden der Erforschung bestimmter Funktionen bei einzelnen Tierarten. Methoden zur Erforschung des Vogelzuges*, von J. Thiene-mann; *Methoden zur Behandlung der Atemphysiologie der Insekten*, von Albert Koch; *Die Verfahren zur Erforschung der Tierfluges*, von Oskar Prochnow. Pp. 123-294. (Berlin und Wien: Urban und Schwarzenberg, 1926.) 7.50 gold marks.

THE first article on the speed and height of the flight of birds is a very brief account of the subject. In the second one, on the respiration of insects (about 80 pages), the function of the spiracles and the movements which ventilate the tracheæ are discussed, and the principal methods for investigating the movements are described and illustrated. Due attention is given to the physical and chemical aspects of the problem, e.g. the technique of gas microanalysis. The third article discusses the flight of insects and of birds and the methods which have been employed in the elucidation of the movements and of their mechanics.

Surface Equilibria of Biological and Organic Colloids. By Dr. P. Lecomte du Nouty. (American Chemical Society Monograph Series.) Pp. 212. (New York: The Chemical Catalog Co., Inc., 1926.) 4.50 dollars.

IN the measurement of surface tension the 'ring' method has the great advantage of rapidity, so that variations are readily discovered; and in the hands of the author of this volume it has proved a most useful weapon of research. The book deals largely with the work of the author, but although its scope is therefore not so wide as the title might imply, it is full of interest to the biologist and the physicist. An ingenious method of deducing the three dimensions of the sodium oleate molecule (leading to a value for Avogadro's constant in remarkable agreement with that obtained in very different ways), the size of the albumin molecule and the differentiation of normal and immune serum are among the subjects dealt with in this work, which should prove singularly attractive even to those who are not specialists.

P. C. L. T.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Origin of the Earth's Surface Structure.

In the *Journal and Proceedings of the Asiatic Society of Bengal* (vol. 8, No. 9; 1912) there is a paper by Dr. L. L. Fermor entitled "Preliminary Note on the Origin of Meteorites."

In approaching his subject Dr. Fermor deals with the effects of pressure in determining the mineral constitution of rocks. He refers especially to the case of eclogite, wherein the development of garnet, and occasionally of diamond, is remarkable. The first represents the allocation of the normal elements present in a gabbroid magma in such a manner as to give rise to the development of minerals possessing the maximum density; the second, the same effect in the relatively rare case of carbon being present. He instances the well-known occurrence of both diamond and garnet in certain eclogites of South Africa. Dr. Fermor concludes that there must be what he calls an infra-plutonic zone deep in the earth's surface materials, and probably extending far downwards, composed of rocks of eclogitic type and, probably, at such a temperature as maintains them in a plastic-solid state. He explains the occasional appearance of this infra-plutonic rock at the surface as due to special conditions whereby cooling forestalls the effects of reduction of pressure during the ascension of the rock; which in this way attains a region of negligible pressure while preserving a mineral structure proper to very great depths. The well-known kelyphite rims, sometimes surrounding the garnets of eclogites, indicate a partial break-down into mineral structures of lesser density.

The recent results arrived at by Dr. Harold Jeffreys (*NATURE*, Sept. 25, 1926), based upon the velocity of transmission of compressional seismic waves, point to the existence of a zone of the density of basaltic glass underlying the granitic continents; the basaltic zone being succeeded downwards by one which Dr. Jeffreys suggests may be dunite. The granitic layer may possess an average thickness of from 20 km. to 30 km. The basaltic zone may have a thickness of about 20 km. The underlying layer may extend to a depth of 1500 km.

Daly has contended for the existence of a general basaltic layer extending beneath the continents and oceans. Other eminent petrologists have held this view. We desire here, in the first place, to cite some recently added evidence in its favour. Washington's discovery of the chemical resemblance of the plateau basalts ejected at various times and at different points of the earth's surface, might in itself be regarded as conclusive. The resemblance, however, seemed to fail respecting the radioactivity of the rocks; the Oregonian basalt showing a much higher radioactivity than the Deccan and Hebridean (*Phil. Mag.*, Nov. 1924). However, we pointed out at the time that the authenticity of our 'Oregonian' material was not perfectly assured. Thanks to the courtesy of Prof. Daly, Prof. Landes, and Prof. W. P. Smith, we have been able to examine specimens of Oregonian basalt of undoubted authenticity, and even a fragment from the specimen chemically investigated by Washington. The average radium and thorium contents of Oregonian rocks from twelve localities come out as closely alike with those already determined

for the Deccan and Hebridean areas. Those who are inclined to limit radioactivity to local conditions will find it difficult to explain away the chemical and radioactive similarity of these enormous and widely sundered outpourings.

Coming now to the third terrestrial layer—the high-density medium underlying the basaltic—it appears that there is no necessity, so far as seismic evidence is concerned, to suppose this layer to differ from the basaltic save in the matter of its mineral structure. The gabbros and the eclogites are magmatically the same. We have found that an eclogite possessing the density 3.415 yielded upon fusion a glass which when cold possessed a density of 2.746, which agrees with the results obtained by Day, Sosman, and Hostetter (*Am. Jour. Sci.*, 37, 1914) for the density of basaltic glass. The density of eclogite—the piezocrystalline form of the magma—would agree with the seismic evidence. It ranges from 3.2 to 3.5. That of dunite is 3.3. We see, then, that seismic evidence is not opposed to the simplifying assumption that the sub-continental materials as revealed in the plateau basalts may extend downwards to a depth approximating to 1500 km. In short, the assumption of the eclogitic character of the third terrestrial layer involves little more than the acceptance of Dr. Fermor's inference that the pressure conditions which convert carbon into diamond in eclogites is also responsible for the high-density mineral structure of these rocks.

However, there is something more to be said. We have found recently that the eclogites possess on the average barely one-half the radium and thorium contents of the plateau basalts. An explanation, we believe, can be offered for this apparently contradictory result; an explanation which, if it is correct, seems to throw light on the origin of terrestrial surface structure and surface history.

Yet the explanation we would suggest is very elementary and simple. We assume that the outer material of the primeval earth was originally compounded of all those siliceous aggregates afterwards differentiated into the layers we have been discussing; and that it was not throughout uniform in chemical composition. There was heterogeneity on, probably, a very varied scale; in some places coarse, in others fine: and this heterogeneity of distribution and association affected the stable chemical elements as well as those that are radioactive. These assumptions seem to be the most general we can make as well as the most probable.

Let us consider first the effects of heterogeneity in the distribution of radioactive elements. This would carry with it thermal heterogeneity. Some parts would melt before others, and when their surroundings were melted would retain a higher temperature and lower density. These parts would gravitate upwards. Again, some parts of lesser radioactivity would retain for longer periods the solid state. In the depths this condition would be especially effective, for here the pressure confers upon the medium the maximum density, as we have seen. Thus the temperature and pressure conditions conspire to preserve to, or confer upon, the medium a high density; and accordingly it gravitates downwards when the fusion of its surroundings permits. Hence it would come about that such gabbroid magma as was poor in radioactive elements—poor in uranium, in thorium, and in potassium—would retain the solid state longest and sink into the depths. It is a fact that eclogite is poorer than the plateau basalts in all three radioactive elements. Respecting potassium, the mean content of K_2O in the five plateau basalts analysed by Washington is 0.89 per cent. The mean

K₂O content of seventeen eclogites cited by Rosenbusch is 0.70 per cent., and of eleven cited by Mlle. Brière (*Bull. Soc. Française de Min.*, 43, 1920) it is 0.37 per cent. They are, in fact, at once the poorest in the heat-producing elements and the densest rocks known.

There would, also, exist a lack of homogeneity respecting the distribution of the non-radioactive elements. Some parts would be richer in silica, alumina, etc.; others in metallic oxides, etc.; such parts would for ever seek to ascend or to descend. Or, in times of thermal loss, certain well-known factors concerned in magmatic differentiation would operate in the same directions.

The final results should be precisely what we find; a highly siliceous and aluminous surface layer rich in radioactive elements and—what seismic evidence reveals—in the depths, rocks of maximum density and, as we now find, of minimum radioactivity. Should these inevitable final conditions be disturbed by the circulation attending a great revolution, they would gradually be re-established during the long later period of thermal loss. We perceive, in short, that heterogeneity in the circumstances is not stable, but must result in radioactive and gravitational stratification. Reversing our line of argument, we might justify our assumption of initial heterogeneity in recognition of the revealed surface structure of the earth.

If these views are correct, it would appear that radioactivity mainly has been responsible for the stratification of the earth's outer materials. It has determined the origin of the radioactively rich and gravitationally light continental layer, of the isostatic layer of intermediate radioactivity and density, and of that more deep-seated layer which only at long intervals takes part in the great events of surface history: the major revolutions ("The Halley Lecture," 1924, pp. 31 *et seq.*, and A. Holmes, *Geol. Mag.*, July 1926). In short, it would appear to have fashioned those structural conditions which have been responsible for geological history and for the development of life upon the globe.

Further evidence of stratification in the earth's great basaltic layer is revealed in the petrology of the oceanic islands. The island basalt—which we must regard as representing the same lava as composes the ocean floor or prevails immediately beneath it—is richer in all the radioactive elements, and at the same time lower in density, than are the plateau basalts. These island lavas reveal, in fact, the final differentiation of the substratum where it attains the surface of the globe; a differentiation referable to physical causes similar to those we have referred to above.

As bearing on all our views of earth-history we would point out that the low radioactivity of eclogite directly affects estimates of geological time based upon the period required to bring about a major revolution. The length of previous estimates will require to be doubled.

J. JOLY.

J. H. J. POOLE.

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Experiments on highly penetrating Radiation from the Earth.

MEASUREMENTS of penetrating radiation of the earth executed at Piatigorsk (in the Caucasus) by means of a portable electrometer covered with lead 1 cm. thick have shown that, though the same apparatus was used, the intensity fluctuated according to the stations of observation where the measurements were made. The fluctuations of intensity were especially marked in places rich in radium, where differences of so much as 100 per cent. were observed between stations separated by a few metres only.

Measurements made at the same observing stations during a period of three years have shown the intensity to be constant and independent of meteorological conditions, and of fluctuations of emanations contained in the atmosphere, within the limits of sensibility of the apparatus.

Measurements of the prevalence of radioactive elements in the upper layers of the soil have shown its constancy, which indicates that the fluctuations were caused by deeper strata only.

The application of four hoods fitting one into the other, each 2 cm. thick and covering the apparatus from above and laterally, and likewise of four flat lead screens covering it from beneath, has shown the influence of the hoods to be very slight, while that of the screens was quite important, indicating that the electrometer was acted upon chiefly from below.

The thickness of lead protecting the apparatus from above, laterally, and from below, having been varied from 0 to 8 cm., the computation of coefficients of absorption was rendered possible. It appeared that the coefficients of absorption by screens varied from 0.45 to 0.06 for 1 cm. Values approaching the lower limit were frequently encountered at different stations. In most cases the value of the coefficient of absorption diminished with an increase of thickness of the lead screens; that is to say, a complex of radiations was being dealt with, some of them possessing a much greater radiating capacity than the γ -rays of radium C. The radiations are directed from below, and their source lies apparently in radio-elements diffused in upper strata of the soil.

The full report of this work will be published in the *Bulletin of the Institute of Practical Geophysics*, Leningrad.

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Spectrographic Observations of the Second Green Line of the Auroral Spectrum.

I THINK that all those who have worked on the spectrum of the aurora will congratulate Prof. Vegard on the notable success he has achieved in photographing so distinctly the line or band about $\lambda 5238$ as recorded in his letter in *NATURE* of Mar. 5, p. 349. The technical difficulties which he had to overcome were formidable.

The present letter is not written in an unsympathetic spirit, but it seems worth while to point out that an interpretation alternative to that of Prof. Vegard is possible. He identifies the band with one which he has observed in the phosphorescent spectrum of frozen nitrogen. But there is a band in about the same position in the negative band spectrum of gaseous nitrogen. Ångström and Thalen (quoted by Kayser in "Spectroscopie") gave the wave-length as $\lambda 5227.5$. The stronger bands of the same series come out with great intensity on Prof. Vegard's photograph as on other photographs of the auroral spectrum: so that it is probable, indeed nearly certain, that a long enough exposure would bring out this band.

If, as would appear from Prof. Vegard's letter, precise wave-length comparisons are not feasible, the criterion of intensity distribution remains. I hope Prof. Vegard may think it worth while to photograph this negative nitrogen band with the same instrument, for direct comparison with the auroral spectrum. It is not unlikely that this would help a decision.

RAYLEIGH.

Terling Place, Chelmsford,
Mar. 23.

Is Darwinism Dead?

IN NATURE of Feb. 19, Sir Arthur Keith brought against me two specific accusations: (1) That I denied in my book "A Companion" (p. 12) the possibility of birds descending from reptiles; (2) that I had given a false reference to Vialleton's high authority. There was a clear issue: (1) Had I said this? (2) Had I misrepresented my authority?

On Mar. 8 I wrote you a brief letter showing that Sir Arthur Keith was ignorant of the great work of Vialleton to which I had alluded, and giving four detailed references. This letter you did not print. In its place you issued, on Mar. 19, a 'comment,' in which you substituted other issues, and repeated as your own the first of Sir Arthur's blunders.

I am therefore compelled to send you this further letter in order that readers of NATURE may be acquainted both with the real issue and its upshot.

(1) I made no affirmation upon the descent of birds. What I did say was that a very great authority (Vialleton) had given strong arguments against the reptilian origin of birds with the natural effect of such an authority so reasoning.

(2) So far from giving a false reference, I had worked upon Vialleton's latest and famous work, and in my letter I gave four page references (585, 588, 590, 592) to that work: of which apparently Sir Arthur had no knowledge, or he could not have blundered as he did.

Your comment leaves your readers under a directly wrong impression upon both points. You re-affirm the error of the first: you make no mention of my specific references in the letter, but only say vaguely that I have caught my critic "referring to the wrong book."

My accuracy, and Sir Arthur Keith's lack of that quality on this issue, can be verified as plain matters of fact by any one who will consult the texts in question.

H. BELLOC.

Reform Club,
Pall Mall, S.W.1, Mar. 28.

MR. BELLOC is under a triple misapprehension. He believes he gave 'references' in his "Companion"; he did not. He left his readers to guess which Vialleton he had in mind; I guessed the right one, and quoted a pertinent passage from Prof. L. Vialleton's best-known work. If Mr. Belloc had been well advised he would have accepted that quotation without comment, for it is less discordant with modern knowledge than the passages of the later compilation to which Mr. Belloc has directed my attention.

In the second place, Mr. Belloc is under a misapprehension as regards Prof. L. Vialleton's range of original work; that writer has never claimed to be an 'authority' on the evolutionary history of birds, nor is he so regarded by zoologists or palaeontologists of any country. I am sure Prof. Vialleton will smile when he learns of the claims which Mr. Belloc now makes for him.

Mr. Belloc's third misapprehension relates to the present state of our knowledge regarding the evolution of birds. The evidence drawn from embryology, geology, and anatomy leaves the expert student in no doubt as to their origin; they arose from a reptilian ancestry.

ARTHUR KEITH.

Royal College of Surgeons, W.C.2.

[No useful scientific purpose would be served by further correspondence upon the points at issue.—
ED. NATURE.]

No. 2997, Vol. 119]

The Atomic Weight of Silver.

THE following few lines give a necessary elucidation to my critical note and to the answer given by Messrs. H. B. Baker and H. L. Riley (NATURE, Mar. 5, p. 348). My principal first theoretical argument is based on the *interdependence* of the atomic weights of the elements silver, nitrogen, and chlorine, resulting from the classical life-work of Richards and his school, in which I have the greatest confidence. If the atomic weight of silver = 107.876, then nitrogen = 14.006 ± 0.0011 , and chlorine = 35.456 ± 0.002 , most probably 35.458. If we accept Baker and Riley's value, silver = 107.864, then nitrogen would become 13.999, a value exceedingly improbable, especially having regard to the fact that Baxter found recently (*Proc. Amer. Acad.*, 12, 12, p. 699, Dec. 1926) by an extremely careful physico-chemical research the value $N = 14.006(7)$, which confirms the higher atomic weight of silver, namely, 107.876. This important argument was not referred to by Messrs. Baker and Riley.

My second, no less important, practical argument was based on the assumption that Messrs. Baker and Riley have lost exceedingly small quantities of silver vapour on fusing the metal in hydrogen, so that the atomic weight found by them is slightly lower than the true one. They did their best to convince themselves that no *visible* condensation of metallic silver could be observed in their tubes, and they say that they have begun a new series of experiments to investigate the volatility and condensability of silver. I beg to remark that some experiments on a large scale in this direction were published by J. S. Stas so long ago as 1865 ("Œuvres complètes," T. I, p. 457), who was my first "atomic weight teacher" in 1875 (but who would read such 'antiquated' papers to-day?). He describes the distillation of 50 gm. of his purest silver in the flame of the oxy-hydrogen blowpipe and says: "Je dois avouer toute fois que, dans les opérations que je viens de décrire, la moitié *au moins* de l'argent employé a été perdue. En effet, il a été entraîné à l'état de vapeur bleue pâle avec le courant de gaz tonnant, quoiqu'il fût cependant modéré, et sans excès trop grand d'oxygène; il a été répandu dans l'air ambiant dont il a troublé la transparence, et auquel il a communiqué une saveur métallique très sensible."

From this important observation it follows that when silver once passes into the state of vapour it is not easily condensed in a solid state, but forms only a colloidal dispersion as a fog. Large quantities of silver heated in tubes give a condensation of the metal, but when a small quantity was heated and fused, the silver vapour—the weight of which was, in the said experiments, of the order of 0.0001 gm. and which would occupy in the solid state 0.00001 cm.³—may have passed out of the apparatus.

Messrs. Baker and Riley say that they controlled the weight of the fused silver obtained by repeatedly melting and weighing it to constant weight. But the question arises: What was the weight of the silver obtained in a fine state of division immediately after decomposition of its oxide by heat and before fusion? Such silver has a very great surface, and during fusion a small loss by evaporation may have taken place. After fusion, its surface has become very small and, last but not least, it was "coated with a very thin film of dross consisting of silica." To these circumstances the fact is very probably due that no appreciable loss of weight of the silver was observed after repeated fusion.

BOHUSLAV BRAUNER.

Bohemian University, Prague, Mar. 10.

Convection of Heat in Fluid Flow through Tubes.

THE convection of heat to or from the walls of a circular tube conveying fluid in turbulent motion has been studied by a long line of investigators, among whom may be mentioned Joule, Reynolds, Stanton, Nüsselt, Soennecken, Jordan, Stender, Heinrich, and Stückle. From dimensional considerations Rayleigh (NATURE, Mar. 18, 1915, p. 66) deduced a formula which, written in non-dimensional form, is equivalent to

$$\frac{ad}{k} = \phi\left(\frac{Vd}{\nu}, \frac{k}{s\mu}\right), \quad (1)$$

where a = coefficient of transmission of heat.

d = diameter of tube.

V = mean velocity of flow.

k = conductivity of fluid.

μ = viscosity of fluid.

ν = kinematic viscosity of fluid = μ/ρ .

h = diffusivity of fluid = $k/s\rho$.

s = specific heat of fluid.

ρ = density of fluid.

For gases Stanton (Tech. Report Adv. Committee for Aeronautics, 1912-13) gave a formula reducible to

$$\frac{ad}{k} = \text{const.} \left(\frac{Vd}{\nu}\right)^n, \quad (2)$$

in which $n = 0.75$ approximately for smooth tubes.

Nüsselt (Z. V. d. I., 1909) proposed a formula for gases reducible to his later form :

$$\frac{ad}{k} = \text{const.} \left(\frac{Vd}{h}\right)^n, \quad (3)$$

which is equivalent to (2) ($n = 0.78$).

Formulae for water of the form :

$$a \text{ proportional to } V^n, \quad (4)$$

have been proposed by Stanton (Phil. Trans. Roy. Soc., 1897), Soennecken (Forsch. Heft 108/109), Stender ("Wärmeübergang an stromendes Wasser," Springer, 1924), and others. These formulae do not make explicit mention of the conductivity. Stender finds that the index ' n ' depends on an equivalent mean temperature $\tau^\circ \text{C.} = 0.9T_m + 0.1T_w$, where T_m = mean water temperature and T_w wall temperature. Experiments with oil have been carried out by Heinrich and Stückle, but not fully analysed (Forsch. Arb. Heft 271).

The object of the present note is to suggest a general formula applicable to all fluids, liquid or gaseous, under conditions of turbulent flow in circular tubes, namely :

$$\frac{ad}{k} = 0.0260 \left(\frac{Vd}{\nu}\right)^f \left(\frac{k}{\mu s}\right), \quad (5)$$

in which $f(k/\mu s)$ is given approximately by the following values :

$h/\nu = k/\mu s$	0.01	0.10	0.40	1.30
$f(h/\nu) = f(k/\mu s)$	0.97	0.895	0.835	0.785

which lie well on a smooth graph.

This formula agrees well with the experiments of Heinrich and Stückle for oil, those of Stanton, Soennecken and Stender for water ($\tau = 10^\circ \text{C.}$ to $\tau = 70^\circ \text{C.}$). It also agrees as well with the results of Jordan, Nüsselt, Pannel, and others for air, as these agree amongst themselves.

A crucial test of the value of formula (5) would be given by experiments with mercury for which the value of $k/\mu s$ lies outside the range of the experiments referred to above.

A complete formula should take account of the ratio of length to diameter of tube, or else the ratio

of initial to final excess temperatures, but (5) is put forward as a step towards the correlation of the results of diverse experiments in which the ratio of length to diameter of tube exceeds about 20.

H. F. F. PURDAY.

70 Bloomfield Road,
Belfast.

The Polishing of Surfaces.

MAY I describe one or two surface-polishing experiments ?

1. The first is more easily described than performed. Prepare a polished biprism having a supplementary angle of 4 or 5 seconds. Continue the polishing of one surface. The debris removed will be carried over the edge and deposited in the minute wedged space between the other surface and the tool. When this space is filled, a continuous perfectly polished surface will be produced and only an appearance of interference on the lee side will betray the original biprism character of the specimen. But under the microscope, and by the judicious use of a steel needle, it will be found that the debris is really only compacted ; it can gradually be broken away and removed. The underlying surface upon which the debris has been deposited retains its original optical polish.

This seems to indicate that, once a group of molecules has been torn from the embrace of its associates, it is practically impossible under polishing conditions to force it back within the region of molecular cohesion.

2. A thermometer embedded in the polishing tool as nearly as possible in contact with the surface will record a rise of temperature of disappointingly small amount. If polishing is due to actual fusion of the 'hill-tops,' it might be expected in practice that, in view of the multitude of the 'hill-tops' acted upon simultaneously, a considerable rise in temperature might be anticipated. This particular theory seems to be based on the assumption that the small amount of energy involved is transmitted into the glass through an extremely minute area. That the area is never extremely small can be observed by carrying out the operation of polishing under the microscope, the action being viewed through the specimen. Within a second or two the area can be extended from about 2 per cent. to 5 per cent. ; in about four minutes the area is about 95 per cent. These results are for a hard pitch polisher. It is remarkable how quickly the pool-like areas spring into view, and an observer will certainly be impressed with the perfection of these areas ; there is no appearance of any intermediate stage suggestive of progressive abrasion.

When the whole area is optically polished, can it be contended that the energy is sufficient to maintain in a state of thermol fusion the whole extent of the surface, however thin the layer may be ? It is necessary to assume that the load is at any one moment carried by a small number of very minute elements, but the test plate applied to an optically polished surface does not disclose any irregularities sufficiently great to penetrate the film of whatever it may be that exists between the surfaces.

JAMES WEIR FRENCH.

Annie'sland, Glasgow, Mar. 19.

The Nodes at the Reduction Division in Bivalents of Hyacinthus.

IN the grasshoppers and some other animals, nodes have been demonstrated in the bivalents, at the late prophase, by Sutton, McClung, Robertson, Wenrich, Janssens, etc. One of the Orthoptera, *Chortophaga* sp., has eleven bivalents and one univalent (X chromo-

some) at the late prophase of the maturation divisions in the spermatocytes. These are well shown in iron-acetocarmine preparations. The writer found that the six largest bivalents showed 23 cases with one node to 19 with two nodes. The smallest five bivalents had only one node each. At each node it was obvious, as had been previously demonstrated by others, that one chromatid from each homologue seemed to pass to the other side, while the other chromatid remained on the same side.

In *Hyacinthus orientalis*, where there are eight bivalents at the reduction metaphase, the four largest showed one or two nodes, while the four small ones had only one node. Out of 116 examples of the four largest bivalents, 62 had one node and 54 had two



FIG. 1.—Bivalent chromosomes in *Hyacinthus*.

nodes. Examination of these nodes showed that one chromatid appeared to pass obliquely across to the other side, while the other chromatid remained on the same side. Also, as in *Chortophaga*, the planes of the V or ring-shaped portions on different sides of a node were more or less at right angles.

The best working hypothesis for these cases seems to be segmental interchange between the chromosomes (crossing-over between genes). Crossing-over is known to occur in some monocotyledons, such as *Zea*. In chromosome I of *Drosophila*, if we calculate the number of nodes which should be seen in the prophases of the maturation divisions of the ova, to correspond with the determined proportions of no, single, and double crossing-over determined by breeding experiments, we find that the results are not far from those given by *Chortophaga* and *Hyacinthus*.

Fig. 1 shows three bivalents of *Hyacinthus*, the central one having two nodes and the other two one node.

JOHN BELLING.

Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor,
Long Island, N.Y.

Magnetic Double Refraction.

THE action of a strong magnetic field in causing a liquid to become birefringent for light rays transverse to the field was first observed by Cotton and Mouton in nitrobenzene, and was later detected and measured by the same authors in many other carbon compounds of the aromatic series and in some inorganic liquids (*Annales de Physique*, 28, 209-243; 1913). In a recent paper (C. V. Raman and K. S. Krishnan, *Proc. Roy. Soc., A*, Jan. 1927) it has been shown that the large value of the Cotton-Mouton constant in aromatic compounds indicates that the benzene ring, which is known from observations on light-scattering to be optically anisotropic, has also a very pronounced magnetic anisotropy. Observations on light-scattering in carbon compounds of the aliphatic series indicate that the molecules of these substances are optically anisotropic to an extent which, though smaller than in the aromatic series, is yet very marked (K. S. Krishnan, *Phil. Mag.*, 50, 697; 1925). It accordingly seemed very probable that the compounds of the aliphatic series should also exhibit magnetic

anisotropy and give a measurable double-refraction in strong magnetic fields.

As Cotton and Mouton did not in their papers report any observable magnetic double refraction in carbon compounds of the aliphatic series except in some isolated cases, we decided to make a systematic re-examination of the subject. A large electromagnet capable of giving 25,000 gauss in a column of liquid 32 cm. long was available to us. By securing the most favourable optical conditions and taking careful precautions to eliminate any disturbance from the Faraday effect or suspended colloidal particles, we have succeeded in definitely establishing the existence of magnetic birefringence in every one of the liquids examined, the list including many hydrocarbons, alcohols, ethers, and esters belonging to the aliphatic series. New pole-pieces are now in course of construction for our electromagnet, with which we hope to reach a field of 40,000 gauss in a liquid column of the same length and to make an extended series of quantitative measurements of magnetic birefringence. There is good reason to believe that such measurements will prove of value in elucidating problems of molecular structure.

C. V. RAMAN.

J. RAMA KRISHNA RAO.

210 Bowbazar Street,
Calcutta, Feb. 15.

An Important Virus Disease of *Lilium longiflorum* and its Varieties.

IN the course of work on the diseases of lilies I have shown by means of controlled experiments that an important disease occurring on *Lilium longiflorum* Thunberg and its well-known varieties of commerce, '*Lilium giganteum*' (*L. longiflorum* var. *takesima* Duchartre), '*Lilium formosum*' (*L. longiflorum* var. *insulare* Hort. apud Mallett), and '*Lilium Harrisii*' (*L. longiflorum* var. *eximium* Baker), belongs to the group of filterable virus diseases and is transmitted by the aphid *Aphis lilii* Takahashi (very close to *A. gossypii* Glov.). The identification of the insect was made by Dr. F. V. Theobald.

The symptoms are a marked downward curling and slightly chlorotic appearance of the leaves. Affected bulbs produce only a flattened rosette, hence the name 'yellow flat' given to the disease.

The disease occurs commonly among bulbs of oriental origin. Rigid government inspection has reduced its incidence in the Bermuda lily fields of '*Lilium Harrisii*' to a practically negligible quantity.

Details will be published in due course.

LAWRENCE OGILVIE.
(Plant Pathologist.)

Department of Agriculture,
Bermuda, Feb. 18.

Salaries of University Lecturers.

PROF. H. E. ARMSTRONG'S recent reference in *NATURE* (Mar. 19, p. 432) to the salary attached to a lectureship in organic chemistry in the University of Sydney may create misapprehension unless it is pointed out that the general scale for lecturers in all subjects at Sydney is £350, rising by yearly increments of £40 to a maximum of £700 per annum. There is little doubt that the conditions for lecturers at Sydney are distinctly more favourable than those prevailing in many, if not most, of the universities of Great Britain.

The University,
St. Andrews.

JOHN READ.

Lister's Contribution to Preventive Medicine.

By Dr. C. J. MARTIN, F.R.S.

LISTER was one of the greatest discoverers in the realm of preventive medicine. His direct contribution equalled in usefulness that ever made by one man; for the antiseptic system of treating wounds relieved mankind from most of the danger and suffering attendant upon surgical operations and permitted the art of surgery to advance to unimagined achievements. His indirect contribution was great and far reaching, but is less easy of assessment.

The obliteration of wound infection which followed the successful practice of antiseptics was an enormous stimulus to research into the causation of infectious diseases generally. These researches received every encouragement from Lister, because he, like Pasteur, was convinced that infectious diseases would be found to depend upon the invasion of the body by the lower world of microbes. From 1851, when he was a house surgeon at University College Hospital, his attention had been focussed upon the causation of inflammation, suppuration, fever, and constitutional disturbance, which at that time almost invariably followed surgical operations. That suppuration was not inevitable was clear, because sometimes wounds healed without it, the edges uniting firmly together in a comparatively short time without any bodily illness. After many fruitless attempts to comprehend the process and causation of suppuration, Lister concluded that it would be wise to attack the problem from the beginning and to study the phenomena of inflammation occasioned in the simplest way. To this end he applied hot water and various chemical irritants to a minute portion of the web of a frog's foot and watched under the microscope the effect upon the blood-vessels and surrounding tissues.

Lister's paper on the early stage of inflammation, published in the *Philosophical Transactions* in 1858, is now classical. In it he showed that inflammation was a reaction of the tissues to a noxious stimulus from without. The problem was: When a wound became inflamed, what was the noxious stimulus? This question was ever present in his mind, but no answer was forthcoming, until in 1865 a scientific colleague directed his attention to Pasteur's studies on fermentation and putrefaction. The full significance of Pasteur's observations was immediately apparent to Lister, as his mind was prepared by his previous experimental work. Infection of wounds by germs, and the action upon the tissues of the products produced by them, would supply the cause he was looking for. Were all these untoward phenomena due to the putrefaction of the liquids exuded by the injured tissues? This inference was tested by ingenious experiments and its accuracy was proved, to the lasting benefit of mankind. It should be emphasised that Lister's discovery of the nature of wound diseases was one of the great steps in the progress of preventive medicine, and antedated by fifteen years the proof that any particular microbe was indeed the cause of disease.

At this time (1865) the enlightened medical world had grasped that Pasteur's discovery that particular fermentations were produced by specific microbes indicated the possible nature of the various *contagia viva* responsible for disease. It was appreciated that diseases bred true, as dogs and cats bred true, and that they did not arrive *de novo*, although their ultimate origin was as mysterious as the origin of species of higher animals or plants. The real nature of the *contagia* was pure guess-work.

The success of Lister's treatment of wounds was a powerful stimulus to the study of the cause of infectious diseases, but, occupied with the development of his antiseptic system of surgery, he could take little part in these researches. Nevertheless, in the intervals of a busy life, he did find time for bacteriological investigations of a fundamental character.

This new realm of scientific discovery yet lacked appropriate methods, and Lister had to forge his tools as required. He carried out these early researches in his back parlour. Their importance and the ingenuity of the methods he devised are dealt with in their proper perspective by Prof. Bulloch in another article in this week's issue of NATURE.

For fifteen years Lister was the principal representative and exponent in Great Britain of the new knowledge, bit by bit unfolded, of the relation of micro-organisms to disease. As his preoccupations increased with his renown, his personal contributions to bacteriological research, perforce, diminished, but the good effect of his encouragement increased.

Whenever the application of bacteriological discoveries to the public health was in question, Lister always took a prominent part. He was president of the Bacteriological Section of the International Congress of Hygiene in 1881, when Koch demonstrated his newly discovered methods of cultivation upon solid media and isolation of different bacteria. In 1890, Koch introduced tuberculin for the treatment of tuberculous infections. Lister, who had a profound respect for Koch, arranged for a thorough trial of the method in his wards at King's College Hospital. Unfortunately, the results, though encouraging at first, proved disappointing.

At the second Tuberculosis Congress in 1901, Lister was in the chair when Koch communicated the results of his experiments upon human and bovine tubercle which had led him to the conclusion that human and bovine tuberculosis were two distinct diseases and that there was no danger for human beings from the consumption of milk or meat from tuberculous cattle. Lister very courteously, but nevertheless trenchantly, criticised Koch's conclusions, pointing out that although the evidence adduced by Koch to show that human tuberculosis could not be communicated to bovines seemed convincing, his reasons for supposing the

reciprocal process to be unusual were far less satisfying. In view of Koch's pre-eminence as a bacteriologist and considering the importance of the question, the Congress moved for the appointment of a Royal Commission of inquiry. This suggestion was adopted by the Government. Lister was not a member of the Commission, but he took an active interest in its labours, and when it reported in 1911, it completely justified the criticisms made by him ten years before.

Another enterprise in the interest of preventive medicine which had Lister's sympathy and active support from its inception, was the foundation in England of an institute for the study of the causation and prevention of disease. The origin of the Lister Institute, as it is now called, was as follows. On July 1, 1889, a meeting was held at the Mansion House, London, for the purpose of taking steps to present M. Pasteur with a grateful acknowledgment from Great Britain of his gratuitous kindness in Paris to more than two hundred British patients who had been bitten by rabid animals. The acknowledgment took the form of a donation of £2000 to M. Pasteur for the use of the Institut Pasteur in Paris. At the same time the committee realised the want in the United Kingdom of an institute similar in character and purpose to the Institut Pasteur in Paris, or to the Hygienic Institute in Berlin, and others, established on the Continent for scientific research into the causation and prevention of the various infective diseases of men and animals.

With the idea of meeting this need the British Institute of Preventive Medicine was incorporated on July 25, 1891, and the objects of the Institute were set forth in a Memorandum of Association, namely :

(a) To study, investigate, discover, and improve the means of preventing and curing infective diseases of man and animals; and to provide a place where research may be carried on for the purposes aforesaid.

(b) To provide instruction and education in preventive medicine to medical officers of health, medical practitioners, veterinary surgeons, and advanced students.

(c) To prepare and to supply to those requiring them such special protective and curative materials as have been already found, or shall in future be found, of value in the prevention and treatment of infective diseases.

(d) To treat persons suffering with infective diseases or threatened with them, in buildings of the Institute or elsewhere.

(e) With a view to effecting these objects, to provide laboratories, to appoint a scientific staff, to institute lectures and demonstrations, to issue publications of the transactions of the Institute, and to found a library.

Lister succeeded the Lord Mayor as chairman of the committee after its first meeting, and was the first chairman of the council of the British Institute of Preventive Medicine. Among his colleagues were Roscoe, Huxley, Ray Lankester, Burdon Sanderson, Horsley, Cheyne, and Sir Andrew Clark. Lister was a regular attendant at the meetings of the council for many years and took the most active part in the management of the Institute.

The office of chairman of the council was for a while no sinecure, and the direction of the new Institute was an anxious task. During its early years it had great financial difficulties to contend with, and on more than one occasion its continued existence was almost despaired of. It was only by means of the enthusiasm and careful guidance of its council and the self-sacrifice of the small body of scientific men which composed its staff that it did not succumb to inanition.

It was also unfortunate in changing its birth name more frequently than is good for a young institution. In 1898 it became the Jenner Institute of Preventive Medicine in order to receive the donation of a sum of money collected to perpetuate the memory of Edward Jenner and his work. Afterwards it was found that a trading firm possessed the prior legal claim to this title, and a further change of designation being necessitated, it was decided to associate the Institute in future with the honoured name of its chairman. It thus, in 1903, became the Lister Institute of Preventive Medicine.

In the meantime the financial stresses which threatened the collapse of the Institute had been considerably relieved by substantial donations from the Berridge Trustees, the Grocers' Company, and a number of public-spirited men. The Duke of Westminster having granted, on terms which meant a large personal contribution, a fine site facing the Thames at Chelsea Gardens, the council proceeded to build one-half of the present headquarters of the Institute. These were opened in 1897.

The permanent income of the Institute was not, however, adequate to the requirements and capabilities of the enlarged establishment, until towards the end of 1898 it received, for the encouragement of research into the cause and treatment of disease, a most generous endowment of a quarter of a million sterling from Lord Iveagh. This endowment enabled the governing body to extend greatly the usefulness of the Institute and to increase the —up to that time—very inadequate staff.

The development of serum therapeutics in 1894 attracted general interest in preventive medicine. A few years previously Behring had discovered that by accustoming an animal to small but progressively increasing doses of tetanus poison, the serum of such an animal possessed the property of neutralising considerable quantities of the poison. This discovery was amplified and put to practical use for the treatment of diphtheria by Roux and Ehrlich, and rapidly established itself as the only rational and effective treatment for this disease.

The preparation of antitoxic sera was at once taken up by the Institute. Some temporary premises near London where horses could be accommodated were acquired, and as soon as the value of the remedy was established the council purchased a freehold property near Elstree, Hertfordshire, where a complete equipment for the production of anti-toxic sera and for research into serum therapeutics was installed.

Since then the activities of the Institute have

increased considerably, but two of the objects for which the Institute was founded, the education of medical officers of health and the treatment of patients, have been discontinued. Elementary education in bacteriology was soon afterwards adequately provided for by the medical schools, and the prophylactic treatment for hydrophobia, which was the particular treatment in view, was no longer required owing to the freedom of the British Isles from rabies.

The advantages which the Institute enjoyed from its association with Lister were, in the earlier days of its history, by no means confined to his guidance

as chairman of its council. To the scientific staff he was always a colleague. Whatever the nature of the problem they were occupied with, they were sure of his sympathy, and his knowledge and critical insight were ever at the disposal of the humblest worker. During the latter years of his life, although no longer able to take an active part in directing its affairs, he did not cease to take a keen interest in the welfare of the institution he had been largely instrumental in founding, and he manifested his confidence in its continued usefulness by making it joint beneficiary with the Royal Society under his will.

Some Aspects of Lister's Scientific Work.

By Prof. WILLIAM BULLOCK, F.R.S.

MY qualifications to write on certain aspects of Lister's scientific work rest on an acquaintance with his published writings. I have studied these critically by themselves and in relation to the writings on the same subjects by his contemporaries. For more than ten years I also had the great privilege of knowing Lord Lister in a manner which, considering the great disparity of our positions, I may say was almost intimate. As bacteriologist to the British Institute of Preventive Medicine I had to visit him as chairman almost weekly, to keep him in touch with the progress of the work in the antitoxin department. Even after I left the service of the Institute he frequently asked me to call upon him in connexion with scientific work in which he was interested. In this way I was a great deal in his company and, among the younger men of that time, probably saw more of him than any one else.

When I first knew Lord Lister he was sixty-eight, and I last saw him in 1909 when he was eighty-two years of age. Both then and since he impressed me as a great personality. He was deeply interested in all advances of medical knowledge and, although leading a very busy life, he strove to keep abreast of bacteriological literature, which was then pouring forth in an unbroken stream. I read through with him most of the complicated papers of Ehrlich and Bordet on hæmolysis. During the reading he would make many suggestions or criticisms which might clear up doubtful points. Finished with the work in hand, he would recur to his own work of early days and indicate the difficulties he had had and how he had overcome them. In a conversation we had on Oct. 23, 1905, he said to me—I wrote it down at the time: "If my works are read when I am gone, my papers on the pigmentary changes in the frog and on the early stages of inflammation will be the ones most highly thought of." These were not the mumblings of senility, for he was then intellectually clear and alert. I took it to mean that he wished to be considered as a scientist rather than a surgical craftsman.

In estimating Lister's scientific work it is essential to remember that he had no properly equipped laboratory as we understand the term

to-day. There were none such, or but few at the time. His laboratory was his study in his private home, and perhaps the best of his scientific work was that done in 11 Rutland Street, Edinburgh, during his first stay in the northern capital. His principal work on antiseptics was done during the Glasgow period, while his bacteriological work was begun and largely completed in his second Edinburgh period when he resided at 9 Charlotte Square.

The hours for Lister's scientific work were early in the morning and far into the night following a harassing day of active surgical work in private practice, or in the wards, operating theatre, and class-rooms of the Edinburgh Infirmary. He performed all his appointed duties in a most conscientious way, and he undertook his experimental work so that he might speak with first-hand knowledge on the themes which he had to teach. Many of the problems he felt impelled to investigate were obscure and complicated, but of the greatest practical importance. Some were not capable of solution then, and others have not yet been definitively cleared up. I refer in particular to his work on the coagulation of the blood and on the early stages of inflammation.

The coagulation of the blood has at all times excited wonderment, and the theories to explain it have been innumerable and are still being brought to light. In Great Britain notable advances were made in the eighteenth century by William Hewson, who unfortunately died of sepsis from a wound before he was thirty-five. In his short life he made, however, many discoveries. He proved that the red corpuscles were biconcave discs; he described their arrangement in masses like piles of money, an observation extended in 1827 by Lord Lister's father in association with Dr. Thomas Hodgkin. Hewson also clearly noted the existence of the white blood corpuscles and performed a large number of experiments on blood coagulation, although he never quite cleared up the mystery of its nature. His successors in the nineteenth century were not more happy. Coagulation of the blood was early studied by Lister. The problem was constantly before him in connexion with intravascular clotting

and the occurrence of putrefaction and secondary hæmorrhage in wounds. The prevailing theory was that of B. W. Richardson, and referred the clotting to the escape of ammonia, which was believed to hold the coagulative elements, normally, in solution.

In a long series of masterly experiments Lister showed that this ammonia theory was untenable. He clearly saw the need of separating the nature of coagulation from the cause, and while baffled with the former he revealed by his experiments that the latter—the cause of coagulation—is really due to the influence exerted on the blood by the contact, even momentarily, of ordinary matter of some kind. He considered that this contact brings about a reaction between the solid and fluid constituents of the blood so that the corpuscles imparted to the *liquor sanguinis* the disposition to clot. As regards the cause of blood coagulation, it cannot be said that we have materially advanced during the seventy years since the publication of Lister's paper.

Another basic pathological process which Lister examined was inflammation. The extraordinary changes which we call inflammation have at all times attracted attention, and the theories intended to explain it constitute a large part of the history of medical doctrines. What is the real nature of the process which we call inflammatory and which results from the application of an *irritamentum* to the body? When Lister began his studies on inflammation, great advances on the older doctrines had already taken place. In England particularly, the science of experimental pathology was in process of rapid growth. The older pathological anatomy so ably created by Morgagni was developed well by the French, among whom the names of Bayle, Portal, Laennec, Bretonneau, Chomel, and Cruveilhier will be brought to mind. Students went from Great Britain to study pathological science in France.

At the beginning of the nineteenth century Edinburgh was a great nursery of medical talent, and many of her graduates migrated across the border to attain fame in the arenas of the south. We all remember with pride the names of Charles Bell, Richard Bright, Thomas Addison, Thomas Hodgkin, C. J. B. Williams, Marshall Hall, William Sharpey, and the peculiarly able if eccentric Wharton Jones. Their work was advanced by the experimental work of Augustus Volnay Waller and of the little-known but successful worker William Addison. Lister had both Sharpey and Wharton Jones for his teachers. The margination of the leucocytes in the inflamed vessels was taught by C. J. B. Williams, and W. Addison about 1842 and Waller (1846) rediscovered the process of emigration of the leucocytes, which had been previously described by Dutrochet in 1827. Wharton Jones summed up in most critical fashion all the work down to 1846, and himself gained the Astley Cooper prize in 1850 for his splendid essay on the phenomena of inflammation.

When, therefore, Lister began to work at the pathology of inflammation he was traversing ground

already trodden. He realised, however, that much that had been done concerned the later stages of the process, whereas the real essence of inflammation was most likely to be found by the study of the earliest stages. He worked chiefly with the frog's web and the bat's wing, and took elaborate precautions that at first the parts should be in a perfectly normal condition. By the application of irritants he then passed to the study of what was pathological. Among the phenomena which he particularly investigated may be mentioned the aggregation of the red blood corpuscles, their increased adhesiveness, and the structure of the arterioles and capillaries. He found that the capillaries alter in calibre, but referred the variation to something inherent in their elasticity. While admitting the phenomenon of contractility in the capillaries, modern workers have not accepted his explanation. Lister regarded irritants as acting in a twofold manner. The primary effect was a dilatation of the vessels brought about by the influence of the nervous system and not limited to the *locus* of the irritant. The secondary effect, on the other hand, was the direct result of the irritant acting on the tissues in consequence of which the blood becomes altered physically. The red discs become more adhesive, they accumulate in masses and may bring about the condition of stasis.

Strange to say, Lister made no reference to diapedesis of leucocytes, and probably missed it altogether. Waller's discovery of 1846 had left so little impress at the time that when diapedesis was described in detail in 1867 by Cohnheim, it was regarded as something altogether new. Previous to Lister's work, the advanced changes in inflammation had been observed and very fully described by Wharton Jones, but it is to Lister's credit that he examined it from a new viewpoint and discussed its significance more than his predecessors had done. He was, however, surpassed by Cohnheim in his classical work in 1867.

When Lister embarked on his extended researches on wound complications and the cause of suppuration, his experimental inquiries on blood and inflammation were a great help to him. He was groping unaided for the causes of suppuration, but light was beginning to peer through the darkness. This was early in his Glasgow term. In 1865 his attention was directed by a colleague to the work which had been done on fermentation and putrefaction by Pasteur, and this came to him as a revelation. Almost immediately he grasped the significance of the Frenchman's work for surgery. Ten years later (1875) he specifically tells us that the work of Pasteur "long since made me a convert to the germ theory, and it was on the basis of that theory that I founded the antiseptic treatment of wounds in surgery."

Although Lister constantly stated his indebtedness to Pasteur, it is, I think, a vulgar error to regard him as a mere copyist of his great French contemporary. So early as 1861, and before he knew Pasteur's results, he was getting near the truth about suppuration, and later on he advanced

beyond the point where Pasteur had led him. No doubt Pasteur revealed to him in a more concrete form what he had dimly foreseen himself, and from then onwards he was ardent in the pursuit of bacteriology. The time would be the early 'seventies, when the study of microbes had not emerged as a definite science. There were at the time two conflicting views. One of these, supported by Ferdinand Cohn, the botanist of Breslau, held that bacteria, like other plants, had a constancy of form which rendered them capable of division into genera and species. According to the other view, there was no morphological constancy, but rather a pleomorphism, whereby one and the same bacterium could assume different forms. If this were true, attempts to cultivate or to separate them on morphological grounds were doomed to failure.

In his earliest work on the subject in 1873, Lister's observations led him to support the pleomorphic theory, and it will now be admitted that he suffered shipwreck upon it when he stated that Ehrenberg's and Cohn's morphological classification was "entirely untrustworthy." Lister's mistake was one which at the time was made by a great many others and tends to indicate the extraordinary pitfalls which beset the path of the earlier bacteriologists. In his life of Lister, Godlee has published an interesting correspondence which passed between Lister and Pasteur on the subject of change of form among bacteria. Pasteur clearly saw where Lister had erred and advised him to repeat his observations with additional technical precautions. This Lister did, and profiting by his new experience he became one of the foremost bacteriological technicians of his time. So imbued was he with the spirit of high ideals that instead of covering up his tracks he handsomely withdrew his error. "Next to the promulgation of truth," he said, "the best thing I can conceive that a man can do is the recantation of a published error." This sentiment was almost identical with that given to us nearly two thousand years ago by Celsus, who, however, added that such a confession

is suited only to a great genius whose splendour is such as to survive the sacrifice, especially in the performance of a task which is to be handed down for the benefit of posterity as a beacon of truth to warn them against similar errors.

From the theory of Cohn and Pasteur it was to be presumed that bacteria might in some way be separated from each other and cultivated in a pure state. The great mycologist, Brefeld, had emphasised the importance of raising such pure strains or cultures from one single germ or cell of a fungus. Following in his wake, Lister was the first to isolate a pure culture of a bacterium. By perfect bacteriological technique involving a complete understanding of the problem, he succeeded in isolating a pure culture of a microbe, *Bacterium lactis*, which is the cause of lactic-acid fermentation in milk. He grew this microbe in sterile milk and raised a pure strain, constant morphologically and physiologically, from a single cell by a series of dilutions carried out with an ingeniously constructed syringe of his own invention. No one can deprive Lister of the merit of having first isolated bacteria in pure culture outside the body. The year was 1877. Lister also introduced the methods of hot-air sterilisation which are in vogue today. His long paper on lactic fermentation is a classic, and a model of what a scientific research should be.

Like Pasteur, Lister had the supreme faculty of seeing as if by instinct the exact experiment needed to clear up a point of doubt. All his scientific work bears witness to this, but I may refer to one other instance of it. In two or three experiments which he did on the fate of catgut implanted in the tissues, he got out all the essential facts in 1869, and later attempts of others in more than three hundred papers down to 1927 have, literally speaking, neither added to nor subtracted from anything which he taught us sixty years ago. He was a master of the experimental method—a rare and precious gift which, the Abbate Spallanzani truly said, "has always been confined and always will be confined to the few."

Obituary.

PROF. CARL RUNGE.

WITH the death, on Jan. 3, 1927, of Prof. Carl Runge, of the University of Göttingen, in his seventy-first year, there has passed away an eminent mathematician and a friend to several generations of English-speaking students in Germany.

Runge, whose mother was English, was born in Bremen in 1856 and was educated at Munich and Berlin. In 1886 he was called to the Technical High School at Hanover, where he remained until 1904, when he moved to a professorship at Göttingen in response to an invitation from Klein. Coming in early life under the dominating influence of Weierstrass and Kronecker, it was not unnatural that his first work should be in the field of function theory and algebra, but the

urge towards the practical, which directed much of his later work, was soon apparent. Many of his lectures at Columbia University, where he went as an exchange professor in 1909-10, deal with this aspect. At Hanover, as a mathematician in an engineering environment, he had perforce to devise ways and means of adapting methods of mathematical analysis to the practical. Many of his numerical and graphical methods, numerical integration, solution of differential equations and Fourier analysis are now commonplace in engineering training. In this respect his influence on German teaching methods was rather similar to that of Perry in Great Britain. Wherever possible he played an active part in actual practical work, as for example when he assisted in a large geodetic survey, and his appreciation of real problems

reflected itself in his teaching and in his theoretical research. His many contributions to the fields of technical mechanics and aerodynamics are evidence of this.

Runge was, however, something more than an engineer, a mathematician, and a teacher. Among experimental physicists he is known for his fundamental work in collaboration with H. Kayser on spectral series, and his work in this field ranks him among those who have laid the experimental basis of quantum mechanics. He examined the spark and flame spectrum of radium. He investigated the magnetic resolution of spectrum lines, and showed that the apparently complex separation may be expressed as simple fractions of that of the normal Zeeman triplet. With Paschen he devised a concave grating mounting that has been adopted in many laboratories. He was pre-eminently one of those all too few men of science who could turn his mind profitably to any field of scientific inquiry with the certainty of producing creative work. Educationally, in Germany his influence was to give a practical orientation to the theorist, and a theoretical outlook to the practical man. To English-speaking students in Göttingen he was undoubtedly the most English of the professoriat, both in appearance and in mental outlook, and he spoke the language fluently. His son was killed early in the War.

H. L.

SIR CHARLES WALSTON.

WE regret to record the death of Sir Charles Walston, the well-known Cambridge archaeologist. Charles Walston (formerly Waldstein, the change in spelling having been effected in 1918 at the end of the War) was born in New York of parents of Jewish stock on Mar. 30, 1856. He was educated at Columbia and Heidelberg Universities, and went to Cambridge at the age of twenty-four at the invitation of Henry Bradshaw and Henry Sidgwick as a lecturer in classical archaeology.

A brilliant and stimulating teacher, with abundant vitality and unbounded enthusiasm, Walston's qualities as an archaeologist and his keen perception of the details of artistic style early won him wide recognition as an authority, and at the same time did much to stimulate the study of ancient sculpture in Cambridge. In 1894 he was elected a fellow of King's College. He held various university posts; among them the readership in classical archaeology, the directorship of the Fitz-William Museum, the Slade professorship from 1895 until 1901 and from 1904 until 1911. From 1889 until 1893 he was director of the American School of Archaeology at Athens, where he conducted important excavations at Plataea, Eretria, and on the Heraion at Argos (1892-1895). After the expiration of his term as director he retained his professorship at the School until 1896.

Walston's more important publications on archaeological and artistic subjects were: "Essays on the Art of Phidias," 1885, "The Work of Ruskin," 1894, "The Study of Art in Universities," 1895; "The Argive Heraion," 1902; "Art in the

Nineteenth Century," 1903; "Herculaneum, Past, Present, and Future," 1908; "Greek Sculpture and Modern Art," 1914; and, quite recently, "Alcmenes and the Establishment of the Classical Type in Greek Art," a work of considerable importance and of broad and comprehensive learning, in which he maintained that throughout the early periods up till the fifth century B.C. one facial type, which he called the Minoan, prevailed in Greek art, differing essentially from the classical type. Walston's interests were by no means confined to his special study, and he wrote on a wide variety of subjects of public interest and, during the War, made a number of contributions to the literature of the time, in which he expounded and interpreted national and social tendencies. In this field his most valuable contribution was "Aristodemocracy," published in 1916, while in "Harmonism and Conscious Evolution," 1922, he set out his theory that the æsthetic principle lies at the root of science, morality, and all man's other activities.

DR. C. DA FANO.

DR. C. DA FANO, reader in histology, King's College, University of London, died with unexpected suddenness at his residence at Campden Hill on Mar. 14, in his forty-eighth year. By his death medical science in Great Britain loses one of the ablest exponents of histology.

Dr. Da Fano was the third son of Commendatore Alessandro Da Fano. He received his early training in histology in Golgi's Institute of Histology and General Pathology at the University of Pavia, where he graduated M.D. in 1905 and later (1912) became *Libero Docente* in morbid anatomy. He obtained a travelling fellowship at Milan and worked in Ziehen's neurological clinic, University of Berlin, in 1908, and in the following year with Dr. Bashford at the Imperial Cancer Research Fund, London. After a period of work at Groningen he returned to the University of Milan as vice-director of the Pathological Institute. From 1915 until 1918 he served as captain in the Italian medical corps on the Italian front. In 1918 he went to King's College, University of London, as lecturer in histology, and in 1922 was given the title of reader in histology in the University.

Dr. Da Fano specialised in the histology of the central nervous system. His advanced lectures on that subject attracted large audiences, and the histological specimens by which these lectures were illustrated formed a complete and noteworthy collection. His researches, published in a series of about sixty papers in various journals, were mainly concerned with the Golgi apparatus in cells and the special lesions of the nervous system in such affections as encephalitis lethargica. He had a very extensive knowledge of foreign languages, and he generously devoted a considerable portion of his time to acting as one of the editors of *Physiological Abstracts*. In 1915 he married Miss Dorothea Landau, and leaves a son and daughter.

News and Views.

IN an article appearing in the supplement to the present issue of NATURE, Sir Joseph Larmor gives a novel interpretation of the local space and time of relativity theory as the absolute space and time of Newtonian dynamics and astronomy. This is clearly not the place to attempt a detailed critical analysis of this important paper, but it may be permissible to summarise a few of the salient arguments. The correlation of past and present astronomical research, as well as the absolute character of atoms, evidenced by spectroscopic research, wheresoever and whenssoever they are found, demand absolute time. The welding of local frames of inertia into one coherent fourfold is the business of relativity; the mutual dynamics of masses existing in each local frame proceeds independently by Newtonian principles. The mathematical development is effected by means of the Principle of Least Action, modified to suit the requirements of electrodynamics and relativity and limited as to form by the necessity of conforming to the postulate of invariance. The requisite formulation of a compound Action-density is first minimised as regards its distribution with reference to variation of structure of the fourfold pseudospace, giving structural differential equations of that fourfold, and then by partial integration the Action is reduced to line integrals along the tracks of the atoms in the fourfold.

By a further minimising of the Action in its new form, Sir Joseph obtains the expression, suitable to the fourfold, of the dynamical interaction of the atoms. An essential feature is that the track of the atom is not treated as an isolated geodesic, determined by the gravitational warping of the pseudospace, of which it is both partial cause and effect, but is connected with other tracks through mutual terms in their potential energy, which are shared between the interacting atoms. In an earlier paper by Sir Joseph (*Phil. Mag.*, S. 6, vol. 45, p. 243, 1923) this sharing of potential energy led to a reduction of Einstein's gravitational constant to one-half of its usual value, because there the time t of the invariant space-time interval of relativity theory was as usual identified with astronomical time. In the article now under discussion, this untoward result is avoided by identifying the local time T , i.e. the invariant time t now corrected for convection by means of the Lorentz transformation, with the absolute time of Newtonian dynamics and astronomy. This procedure leads to Einstein's values of the displacement of spectral lines and of the gravitational deflexion of rays of light, but apparently not to his result for the progressions of planetary perihelia, a conclusion regarded by Sir Joseph as not unsatisfactory in view of the uncertainty of the progression of the perihelion of Mercury, as shown in recent astronomical discussions. Moreover, it leads to the proper relation between electric mass and energy relative to the fourfold, a relation which is not substantiated at all except on the present Newtonian scheme.

APRIL 5 was the centenary of the birth of Lister, physiologist, pathologist, and the 'father of modern surgery,' and elsewhere in this issue Dr. C. J. Martin and Prof. W. Bulloch describe some aspects of his life and work. Celebrations of the centenary commenced in London on April 4, when H.M. The King received delegates from learned societies, universities, and medical societies in Great Britain, from the Dominions and many foreign countries, who are attending the ceremonies arranged by a joint committee of the Royal Society, the Royal Colleges of Physicians and Surgeons, the Royal Society of Medicine, the British Medical Association, and other bodies. Sir Ernest Rutherford, president of the Royal Society, presented an address to the King, to which His Majesty replied, expressing the hope that the gathering of scientific workers for the centenary celebrations would "strengthen the co-operation of all nations in the accumulation of scientific knowledge for the common benefit of the human race." Personal memories of Lister were given by Sir St. Clair Thomson in an address before the Royal Society of Medicine in the evening, and by Sir Watson Cheyne and Sir George Lenthal Cheatle at a meeting in the afternoon of the Listerian Society. On April 5, the official delegates of centenary celebrations were received by the Prime Minister at the house of the British Medical Association, and on the following day a memorial service was held at Westminster Abbey. We hope to give an account of the proceedings in an early issue. Centenary celebrations at Glasgow began on April 1; those arranged at Edinburgh will be held concurrently with the annual meeting there in July of the British Medical Association.

THE text has been issued of the Destructive Insects and Pests Bill, which was introduced into the House of Commons by Mr. Guinness on Mar. 25. This Bill provides that an order under the Destructive Insects Act, 1877, as amended by the Act of 1907, may enable an authorised inspector of the Ministry of Agriculture to take necessary action with reference to any crop infected with an insect specified in the order as being a destructive insect within the meaning of the principal Act, which has been introduced into Great Britain. The Act provides that such an inspector may remove or destroy, or cause to be removed or destroyed, any crop infected, or any crop by means of which the insect is likely to be spread. The Bill also provides for the payment of compensation in respect of any crop removed or destroyed. Until now, very few introduced pests have gained a footing in Great Britain, but the provisions under the new Bill are timely precautions. A few years ago the Colorado potato beetle became established in the Bordeaux district of France and its eradication now seems scarcely possible. The entry of such a pest into Great Britain would constitute a menace to a crop that suffers to an almost negligible extent from insect pests. Notwithstanding precautions against their admittance, foreign pests may secure a foothold, and

the new Bill provides for the necessary action in the event of such an occurrence. The heavy infestation of cherries from some parts of the continent with the cherry fruit fly is another case in point, but happily that insect likewise has not yet become established in Great Britain.

THE first statutory general meeting of the British Mosquito Control Institute was held at the Hotel Cecil, London, on Mar. 30, when the council was elected in accordance with the articles of association approved by the Board of Trade, and by which the Institute is registered under the Companies Acts, 1908-1917, as a company limited by guarantee and not having a share capital. Since the anti-mosquito campaign was begun at Hayling Island about seven years ago, it has become increasingly evident that the work so successfully accomplished there is of more than local interest, and that medical officers of health and sanitary inspectors in many parts of Great Britain, as well as abroad, desire to know how to keep mosquitoes under control. The Ministry of Health can only concern itself with these insects as disease carriers, even though in some districts they make life out of doors almost intolerable in certain months of the year. The Natural History Museum is always willing to identify specimens and give general guidance on methods of dealing with them, but neither it nor the Ministry of Health is concerned with actual field operations by which the mosquito nuisance may be reduced or eliminated. This practical knowledge is, however, available at the British Mosquito Control Institute at Hayling, where there is now a substantial building with laboratory, museum, photographic room, and other facilities for the study of all stages of mosquito life and its regulation. The Institute has been vested in trustees by the founder and director, Mr. J. F. Marshall, whose devoted services in solving problems of mosquito control are widely known and appreciated. Membership is open to all who are interested in the subject, and it is hoped that, in due course, sufficient support will be forthcoming from members and public bodies to make the Institute self-supporting and extend its activities. The council includes among its members Sir Ronald Ross, Sir William Simpson, Sir Arthur Shipley, Dr. Andrew Balfour, Major E. E. Austen, Sir James Crichton-Browne, Dr. G. A. K. Marshall, Dr. C. M. Wenyon, and other entomologists familiar with the mosquito pest, and the chairman is Sir Richard Gregory. The address of the Institute is Hayling Island, Hampshire.

CAPT. C. W. R. KNIGHT's kinematograph exhibition "Filming the Golden Eagle" should be seen by every one interested in wild life. It began a short season at the Polytechnic Theatre, Regent Street, W.1, on April 2. By means of this excellent film one is enabled to make intimate acquaintance with one of the finest and least common species in the native avifauna of Great Britain. The pictures were taken last year at three different Scottish eyries, and many interesting incidents from the lives both of the young

and of the mother bird are shown. In one case, Capt. Knight was even able to follow the young with his camera for some time after they had left the nest and were able to fly. Perhaps the most striking items are the slow-motion pictures of the adult bird in flight: these include photographs of a trained captive eagle catching the lure in mid-air. In addition to various incidental pictures, there are also some short episodes from the lives of other birds, and those of the chaffinch and of the longtailed-tit are particularly good.

A DISPATCH from Cairo dated Mar. 31, which appeared in the *Times* of the following day, announces the discovery at Saqqara by Mr. Cecil Firth, working for the Department of Antiquities, of a tomb of the Third Dynasty of about 2900 B.C. The tomb, which has a rounded top, is situated on part of the wall about a mile long which surrounds the Step Pyramid. It is thought that it may be the tomb of Imhotep, the architect of the Step Pyramid. An interesting feature of the tomb is the work of low relief on the doors of the underground rooms. Each represents Pharaoh Zoser in the finest artistic style of the period, and although the figures stand out only a millimetre, each muscle is distinctly shown. Twelve magnificent alabaster jars nearly three feet high were found.

DR. GANN's preliminary account of his explorations during the past winter in British Honduras, which appeared in the *Morning Post* of Mar. 28 and two succeeding days, again provides material of much interest to the student of Central American archaeology, although it contains nothing so sensational as his discovery last year of the early dated stele at Chetumal Bay. An unsuccessful search for a bilingual record, which might play the part of a Central American Rosetta Stone, in the first Spanish church at Villa Real, the settlement founded by Davila in 1528, was followed by a visit to a camp on the lagoon On Ha on the northern boundary, where excavations on burial mounds produced evidence of Toltec influence on the Maya in the form of a clay squatting tiger with a human head protruding from its mouth. Northwest from Sac Xan on the Rio Hondo, Dr. Gann discovered great ruins of a temple structure 120 feet high, of which the roofs must originally have been at least 160 feet from the ground. It contained a single chamber 58 ft. long, 18 ft. high, and only 3 ft. wide. Chambers in other buildings were as narrow, or even less in width. The Maya ignorance of the principle of the true arch and their employment of the method of overlapping stones in roofing restricted the width of their buildings to at most 16 ft., but nothing proportionately so narrow as these chambers is known in Central America. Dr. Gann conjectures that they were constructed for ceremonial purposes.

AN exceptional opportunity for the comparative study of folk-dances will be offered by the festival to take place at Bayonne on April 27 and 28. It is being organised by the Musée Basque de Bayonne. A team of fourteen dancers of the English Folk Dance Society will take part in the festival and will give

two performances, one at the annual ball in aid of the funds of the Musée, and the second on the afternoon of the following day, when the English dancers will dance in alternation with teams from the Basque provinces of La Soule, Labourde, Basse Navarre, and Guipuzcoa. As some of the dances from these provinces, each of which has its own tradition, are of a very primitive type, yet in certain features present resemblances to some English folk-dances, their presentation at the same performance should be highly instructive. It will be remembered that Miss Violet Alford, both in the paper read before the British Association at Oxford last year and later, in the autumn, at the joint meeting of the Royal Anthropological Institute and the English Folk-Dance Society (NATURE, Dec. 4, 1926, p. 824) stressed the significance of the *Danse de l'Ours* of Basse Navarre in relation to the meanings of some of the primitive traits in English dances, and she is now engaged in carrying her researches further in the Pyrenees area. The English Folk Dance Society's party, which will include in addition to the dancers any members of the Society and their friends who wish to avail themselves of this opportunity, will leave for Bayonne on April 24.

MR. J. ALLEN HOWE delivered the Friday evening discourse at the Royal Institution on April 1, taking as his subject "The Stones of London." Situated on a sub-stratum of clay and incoherent gravel, London, from its very beginnings, has had to go beyond its borders for stone. In the fragments of the Roman Wall we have evidence that its builders sought the slopes of Hertfordshire for boulders of hard sarsen stone, the Downs and the Weald of Kent for chalk, ragstone, chert, and freestone; while the local flint gravel was freely used then as now. The Normans introduced the stone from Caen, of which examples may be seen in the Tower, Westminster Abbey, and other buildings. Beer stone from Devon and the somewhat similar Clunch stone, both from the Chalk formation, were much in demand for carving from about the eleventh century; while for columns, beautifully exemplified in the Temple Church, the marble of Purbeck was the favourite material. From the Great Fire of 1666 a new stone era began for London; although many other stones have been and still are employed, Portland stone from that time began to play a dominant part. The majority of London's buildings are now built or faced with limestone, which is readily attacked by the acid-laden town atmosphere, yielding calcium sulphate in the process; this is in itself a cause of further destruction, as the solution soaks into the stone and there crystallises. In the presence of the acid-bearing air the principal cause of unsightly decay is a state of dampness, which may be conditioned by the aspect, the construction, or the design. Continual efforts are being made to discover a preservative that will not impair the appearance of the stone. The least objectionable of these processes, for example, the various silico-fluorides, are liable to prove ineffective after a comparatively short period, and the latest,

Dr. Laurie's silicon-ester, is still on trial. The difficulty with all external applications is imperfect penetration with the consequent danger of skin formation.

THE annual lecture to the Graduate Section of the Institution of Mechanical Engineers was given by Sir John E. Thornycroft on Mar. 28, his subject being "Torpedo Boats and their Machinery." It is more than sixty years ago that Sir John I. Thornycroft began steam-boat building at Chiswick, and it was his work and that of Sir Alfred Yarrow which made the Thames famous as the home of the high-speed vessel. There is no more fascinating story in engineering than the history of torpedo craft, from the early boats of 30 tons to the destroyers of to-day of more than 2000 tons. The latter have boilers and turbines of more than 40,000 H.P. giving a speed of nearly 40 knots. Turbines have been fitted for twenty years, but in the four-cylinder triple expansion engines of earlier destroyers mechanical engineering of the nineteenth century reached its highest pitch of excellence. The speed at which they ran, the lightness of their construction, and the conditions under which they worked, were all remarkable. Sir John in his lecture gave comparative figures which showed that the machinery of a liner in 1855 weighed more than 600 pounds per horse-power, while in a modern destroyer the corresponding figure is 30 pounds. In the coastal motor boats built during the War and fitted with internal combustion engines, the weight was only 12½ pounds per horse-power.

At a meeting of the Newcomen Society on Mar. 30, a paper on "Lead Mining and Smelting in West Yorkshire" was read by Dr. A. Raistrick. In the course of his paper Dr. Raistrick traced the history of lead mining in the Yorkshire dales from Roman times down to the present day, giving notes on the method of quarrying the ore, smelting it, and its sale and transport. Lead pigs are in existence bearing the names of Roman emperors, and there is evidence to show that the industry was carried on continuously, practically down to the present time, though to-day little is being done. The cheaper ores from Spain and elsewhere have been the main cause of the decline, but as foreign mines have to go deeper and instal more machinery, the ore will increase in price and thus the Yorkshire mines may again become profitable. The paper contained much of interest to those who study the history of mining.

PURCHASES during March for the Department of Zoology of the British Museum (Natural History) included a collection of rare land-snails of the genus *Nenia* from Peru, Bolivia, etc., and a remarkably fine golden eagle from Norway. The Trustees also purchased, for the Department of Geology, seven specimens of an ancient roofed-head amphibian, *Protriton*, from a new locality in Thuringia. This little salamander-shaped animal is well preserved in a dark oilshale of Lower Permian age; it is one of the *Branchiosauria*, which owe their name to the indications of gill-arches in the skeletons of immature individuals. A large collection of skulls and heads of African game animals was presented by Major C. H. B.

Grant. These are particularly valuable since they are accompanied by full details of locality, season, and the like; many of them represent species or races that are now in danger of extermination. Among other donations submitted to the Trustees was a small series of fossil-bearing rocks obtained by the Norwegian expedition of 1921 from the palæozoic formations of Novaya Zemlya. A nodule containing a V-shaped burrow, probably formed by a kind of lob-worm, was presented by Dr. S. H. Haughton, who obtained it from the Upper Dwyka shales of the Warmbad District, South West Africa; it suggests that these rocks were formed on a tidal flat. Mr. J. R. T. Regan presented some curious branching structures, probably worm-tubes, found by him in the Totternhoe Stone near Dunstable. Other donations included nummulites from north-west India described by Major L. M. Davies, and type-specimens of shells from a fresh-water sandstone of unknown age in the Fiji Islands collected by Dr. Matley.

THE completion of a second submarine cable connecting Canada with Australasia is an event of considerable importance. E. S. Heurtly, in an article in the *Electrician* for April 1, gives many interesting details of the work. It involved the laying of two cables, one between Bamfield, on Vancouver Island, and Fanning Island (3466 sea miles) and between Fanning Island and Suva, Fiji Islands, a distance of 2054 sea miles. The original cable, which was laid in 1902, had a working speed of about 75 letters per minute. By using amplifiers, however, its speed has been increased to about 135 letters per minute. The maximum speed on the new northern cable is at least eight times as great as that of the original cable, and the received voltage at Fanning Island is at least five times as high. The great improvement in the traffic-carrying capacity of the two cables is due to the 'loading' of the cables by alloys of nickel-iron, which have a very high permeability for very low magnetising forces. The 'chrome permalloy' used for loading the southern cable has better electrical characteristics than that used on the New York-Azores cable. The original cable has one advantage over the new cables, as duplex working can be used with it. Owing to the difference in times between Europe and Australasia there is little overlapping of the messages going in opposite directions, and consequently this is not a serious drawback to the new cables. Accurate measurements of the time of propagation of the signals between Bamfield and Fanning Island have been made by means of a siphon recorder used with an amplifier and a tuning-fork. The mean of all the results shows that the signal takes 0.67 of a second to travel 3466 miles. When signalling, therefore, at 1000 letters per minute, more than 40 impulses may be in the cable at the same time.

ONE of the most remarkable of recently constructed tunnels is the Rove tunnel on the new canal between Arles on the Rhone and the port of Marseilles, by the use of which river traffic can avoid the delta or the crossing of the sea between the terminus of the old canal at Port au Bouc and Marseilles. A fully illustrated article on the canal water appears in *La Science*

Moderne for February. The Rove tunnel under the Nerthe hills is nearly four and a half miles long. It has a width of 72 feet, of which 13 feet are utilised by the pathways beside the canal. The depth of water is seven feet and there is room for two streams of canal traffic, with a height above the water line of about 43 feet. Apart from through traffic, this canal promises to be of value in the new scheme, now under way, of making the great Étang de Berre, beyond the northern end of the Rove tunnel, a great port, accessible by large vessels from a wide and deep ship canal at Port au Bouc. Around this extensive harbour is ample room for manufacturing sites. Provided the water power of the Rhone and its tributaries is made available, the port of Marseilles may well become a great centre of manufacturing industry.

THE magazine of the Geographical Association, on reaching its fourteenth volume, has been named *Geography* in place of the original title *The Geographical Teacher*. The change in name involves no change in policy or scope. It is still to be published three times a year and to be devoted to the interests of teachers, but its general appearance and production have been much improved. In addition to the usual short articles, notes for teachers, and reviews of geographical books, the spring number contains Sir Charles Close's presidential address on "Population and Emigration," in which he makes a statistical study of Empire settlement. In the belief that the Dominions can absorb annually about five per thousand of their total population, he estimates that Great Britain could send overseas about 100,000 emigrants a year apart from the number that go outside the Empire. He gives a total of about 168,000 as the reasonable annual emigration.

No. 4 of the *Quarterly Review of Biology* completes volume 1, and the editors, Profs. Raymond Pearl and R. W. Hegner, are to be congratulated on the success of their initial volume. The trustworthy and readable articles on subjects of current interest and importance in various fields of biology, and the helpful notices of new biological books, have established the reputation of this new *Review* and have made it what its editors intended it to be—useful to the professional biologist, to the worker in other sciences who wishes to maintain his general interest in biological progress, and to the intelligent lay reader. The principal article in this issue (No. 4) is a comparative account by Dr. Adolph H. Schultz of the foetal growth of man and other primates, which is excellently illustrated by drawings, diagrams, graphs, and tables. The London agents for the journal are Messrs. Baillière, Tindall and Cox, 7 and 8 Henrietta Street, Covent Garden, London, W.C.2.

DR. P. CHALMERS MITCHELL will deliver the annual Huxley Memorial Lecture at the Imperial College of Science and Technology, South Kensington, on May 4, taking as his subject "Logic and Law in Biology."

SIR JAMES BERRY, president of the Royal Society of Medicine and author of standard works on surgical subjects; Sir H. Walford Davies, professor of music, University College of Wales, Aberystwyth; and Sir Frederick Keeble, formerly Sherardian professor of

botany. University of Oxford, and distinguished by his work in pure and applied botany, have been elected members of the Athenæum Club under Rule II., which provides for election by the Committee of "persons of distinguished eminence in science, literature, or the arts, or for public services."

THE annual dinner of the British Science Guild will be held at the Criterion Restaurant, London, on Thursday, May 12. Lord Askwith will preside, and the guests include Sir Alfred Mond, Sir Herbert Samuel, the Hon. W. Ormsby-Gore, Sir William Pope, and Sir Frederick Keeble. Particulars may be obtained from the Secretary, British Science Guild, 6 John Street, Adelphi, W.C.2.

At the annual general meeting of the Ray Society held on Mar. 24, the following officers were re-elected: *President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Dr. G. P. Bidder was elected a vice-president, and Mr. J. Spedan Lewis and Mr. F. Martin Duncan were elected new members of council. It was announced that the Society's issue for 1927 would be the first volume of a "Monograph of British Sea Anemones," by Dr. T. A. Stephenson, which will be illustrated with coloured plates from the author's drawings of the living animals. It is expected that this work will prove unusually attractive as well as of great scientific interest.

Our Astronomical Column.

THE BIELID METEOR SHOWERS.—Mr. Willard J. Fisher, of Harvard Observatory, contributes a paper to *Proc. Nat. Acad. Sciences*, Dec. 1926, in which he collects a large amount of material relating to various apparitions of these showers, and plots them in the endeavour to trace the laws of their recurrence. In 1741 and 1798 the shower occurred on Dec. 6 and 7; there were also December showers in 1830, 1838, and 1847, but all since then have been in November, owing to the motion of the node. On plotting the showers they appear to group themselves along four different lines, indicating presumably that there are several condensations of meteors along the orbit, their periods being slightly different. Many of the brighter showers are separated by intervals of 13·0 years (double the period of the comet). It is noteworthy that three of the four lines in the diagram converge towards a point a few years ahead of the present time, when the date of the shower will be Nov. 16. It will be well, therefore, to keep a careful watch for these meteors in coming years.

COMET GRIGG-SKJELLERUP.—It is curious how this comet has consistently been associated with the British Astronomical Association. It was found both in 1902 and 1922 by members of the Association, Mr. J. Grigg of Thames, New Zealand, and Mr. Skjellerup of Cape Town. The suggestion of identity was first made by Mr. R. T. Crawford and Mr. W. F. Meyer of California, but it was Mr. G. Merton, another member of the Association, who finally proved it, and made a prediction for the return of the present year.

Mr. F. J. Hargreaves, the director of the photographic section of the Association, was the first to photograph the comet at the present return, on two successive evenings, Mar. 27 and 28. It was Mr.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master for mathematics at the Government High School, Nassau, Bahamas—The Board of Education (C. A. (T.)). Whitehall, S.W.1, or The Scottish Education Department (T.), Whitehall, London, S.W.1 (April 11). An assistant pathologist at the Charing Cross Hospital Institute of Pathology—The Secretary of the Institute, 62 Chandos Street, W.C.2 (April 25). Junior assistants in the aerodynamics department of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (April 30). A lecturer in geography at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (May 7). A professor of agriculture at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (May 20). An assistant in the Dominion Museum, Wellington, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (May 31). An assistant in the Laboratory of Zoophysiology of the University of Copenhagen, mainly for research work in respiratory metabolism and gas analysis—Prof. A. Krogh, The University, Copenhagen. A teacher of design, with special reference to the textile industry, at the Leicester College of Arts and Crafts—The Registrar. A senior biology mistress at the Cheltenham Ladies' College—The Principal.

Merton who detected the very faint images of the comet, Mr. Hargreaves having overlooked them. Further confirmation was obtained by a photograph taken by Prof. Schorr at Bergedorf on Mar. 31. Mr. Hargreaves uses an aero-lens of 20 inches focus, the mounting being home-made. It is a great encouragement for amateurs that this tiny equipment beat the instruments at the Yerkes and Harvard Observatories, which reported in the same week that they could obtain no trace of the comet. The explanation is that such large, faint, diffused objects are specially adapted to small-scale photographs using a large light-ratio. The deduced date of perihelion is May 10·245, 1927, U.T., which is only one-tenth of a day earlier than Mr. Merton's predicted date, May 10·34. This date had been communicated to Mr. F. E. Seagrave, who published ephemerides based upon it, but without mentioning Mr. Merton's name.

The corrected elements are as follows:

$$\begin{array}{rcl} T & 1927 \text{ May } 10\cdot245 \text{ U.T.} \\ \omega & 355^\circ 1' 48'' \\ \Omega & 215 \ 32 \ 1 \\ i & 17 \ 29 \ 18 \\ \phi & 43 \ 48 \ 58 \end{array} \left. \vphantom{\begin{array}{rcl} T \\ \omega \\ \Omega \\ i \\ \phi \end{array}} \right\} 1927\cdot0$$

$$\log q \ 9\cdot95068$$

$$\text{Period } 4\cdot98772 \text{ years.}$$

Ephemeris for 0^h U.T.:

	R.A.	Decl.	[log r .	log Δ .
Apr. 6.	5 ^h 58·6 ^m	1° 25' S.	0·0123	9·7642
14.	6 11·8	1 17 N.	9·9896	9·7213
22.	6 27·3	4 43	9·9707	9·6676
26.	6 36·1	6 49 N.	9·9633	9·6363

The comet will approach within 19 million miles of the earth early in June. It will probably be a difficult object to observe accurately, being large and diffused.

Research Items.

THE DIVINITY OF THE GUEST.—In the *Ceylon Journal of Science*, vol. 1, Pt. 3, Mr. A. M. Hocart discusses the position of the guest and his relation to his host in ancient Greece, in India, and in Fiji. In ancient Greece no distinction was made between a stranger, a host, and a guest, as they were not distinguishable. Further, not only was the god present with the stranger, and Zeus the patron of strangers, but also he was often regarded either as a god or actually was a god, as is shown in the manner in which Odysseus was addressed in Phaeacia. The exchange of gifts and the return of hospitality, potential or actual, created a bond of hereditary guest friendship out of which grew the consular system in historical times. The idea that the god accompanied strangers was evidently a check on an un hospitable age. In India, in the Atharvaveda the divine character of the guest is worked out in detail, every act of hospitality being identified with some phase of the sacrifice to a god. In the Anguttara Nikaya, the offerings to the Manes include a reception of guests, who are selected either as being learned or virtuous Brahmans, or as being relations through females. In Fiji, various ceremonial observances towards strangers, including the making of gifts, point to their sacred or heavenly character. In Fiji, however, intercourse takes place only through kinsmen, the kinship being either actual or, in case of necessity, fictitious. It is reckoned through the female. There was also a system of official guest friends. It is suggested that the Homeric system may have developed from some such archaic form as the Fijian, India being the common link in which the offerings to kinsmen and guests are distinguished, while in Fiji the recipients are identical; but in both countries divine honours were accorded to guests. The resulting hypothesis is that the divinity of the guest grows out of the divinity of the kinsman, who stands in cross relationship to the host, and this is extended fictitiously to any stranger.

WEAPONS AND ARMOUR OF THE PHILIPPINE ISLANDS.—A description by Mr. Herbert W. Krieger of the collection of primitive weapons and armour of the Philippine Islands in the United States National Museum, which appears as No. 137 of the Museum's *Bulletin*, is of a wider ethnological scope than its title might suggest. The author, in his introductory remarks, deals not only with the history of the collection, which is derived from a variety of sources, and has been given at different times, but also with the development of the types of weapons of the Islands and of their tribal cultures. The various types preserved in metal, bone, wood, and horn, bear traces of the several waves of civilisation that have reached the Philippines. They extend from the primitive digging stick, which may be a club or, with slight adaptations, an axe, a spear, a sword, a knife, or a hoe, down to the cannon of brass and firearms of Spanish manufacture in the possession of insurrectionary native troops. Tribal groups and nationalities manifest in their weapon production and types of body armour and shields a nearness to, or remoteness from, foreign culture influences. No one group has retained exclusively any one type of material culture. Some elements survive from a primitive Melanesian strain; other tribes show borrowings from the aboriginal Negrito; the Batak use the blowgun, a typical Malay weapon, while the Negritos of Zambales and the Luzon east coast use the Malay shield. Fine iron and steel blades, which have come to be recognised as characteristic of the Mohammedanised Moros,

show a decorative design on the blade and a blade form invariably of Hindu or Arab character. Although the Spaniards found a crude crucible of stone in use for crushing gold ore and quartz, there appears to have been no stone age in the Philippines. Bamboo furnished in early days all the material required for implements and weapons until those made of iron were introduced from Borneo.

CLASSIFICATION OF HEMIPTERA.—The greater part of Vol. 7 published by the Connecticut State Geological and Natural History Survey, 1923–1925, is occupied by an extensive memoir of more than 800 pages forming Bulletin 34 of the Survey and entitled "The Hemiptera or Sucking Insects of Connecticut." Its author, Dr. W. E. Britton, in collaboration with a number of specialists in different families of the order, has provided a trustworthy and authoritative guide to the classification of Hemiptera, which will be found useful to entomologists in many countries. The bulletin is virtually a text-book on its subject and is well illustrated and provided with a full index.

DISTRIBUTION OF FOOD FISHES IN THE NORTH SEA.—In *Fishery Investigations* (Min. Agric. Fish.) ser. 2, vol. 9, No. 4, 1926, Mr. J. O. Borley provides a series of most instructive charts portraying the quantitative distribution of the marketable sizes of the principal food fishes in the North Sea during the years 1923 and 1924. It should be noted that only fish taken by the trawl are treated; species such as the herring, which are very largely caught in other nets, are dealt with only in so far as they are trawled. The charts are drawn up from the landings of British steam-trawlers, referred to the place of capture. The areas to which landings are referred are small rectangles each 1° of longitude by 30' of latitude; these vary somewhat in extent with latitude, from 1500 square miles in the southern bight of the North Sea to approximately 1200 square miles in the region of the Shetlands. Each chart depicts a set of contours which indicate the relative frequency of occurrence of one particular trade category of fish, in grades of abundance from less than 1 cwt. to more than 100 cwt. per 100 hours of fishing. A loose key-chart, printed on transparent paper and showing the approximate position and names of some of the chief fishing grounds, is provided, which may be superimposed on the others as desired. The whole work demonstrates very clearly the scientific value of the carefully compiled statistics of commercial landings at British ports. Some notes on the natural history of the fishes dealt with in the charts, prepared by Miss Thursby Pelham from a variety of sources, form a supplement to this publication.

FLEAS AND PLAGUE.—Vol. I., Pt. 4, of the *Ceylon Journal of Science* (Dec. 1926) is devoted to the results of researches by Dr. L. Fabian Hirst on the parasitology of plague. He has returned to the important problem of the transmission of plague by the fleas *Xenopsylla cheopis* and *X. astia*. All attempts to transmit plague between rats, mice, and guinea-pigs by means of *X. astia*—596 fleas and a variety of methods were employed—at room temperature in Colombo during four plague seasons gave negative results. Plague was successfully transmitted to twelve rodents by means of 95 *X. cheopis* in the course of six separate experiments at room temperature. Plague was successfully transmitted from mouse to rat at an artificially reduced temperature (70° F.) by means of *X. astia*; a female flea of this species with 'blocked'

proventriculus transmitted plague to two out of four of the rats on which its bites were observed. Rise of temperature may exert an unequal effect on the transmitting power of two different species of rat-flea. The second part of the work deals with the bionomics of the two species of fleas—egg-laying, life-history, longevity (that of the female being greater), factors which influence biting, etc. A useful list of the rat fleas of the world is given, and appended is a brief account, with seven plates, by Stanley Hirst, of the principal species of Acari parasitic on rats.

POLLINATION EXPERIMENTS WITH PEAS.—More detailed observation of Mendelian ratios is revealing consistent departures from expectation, which have to be explained by differences in the conditions under which the pollen tubes grow down the style of a flower or in the viability and rate of growth of pollen tubes, as well as by reference to other features of flower structure. Dr. C. J. Bond (*Jour. of Genetics*, vol. 17, No. 3) has experimented on these points by pollination of the F_2 hybrids between pea varieties having respectively round yellow and wrinkled green seeds. By pollinating immature stigmas, he finds an increase in the recessives resulting, presumably because the pollen grains bearing the recessive factors, and probably containing more sugar, are more viable or grow faster when the stigma is finally ripe. He also finds a small increase in the proportion of recessives when minimal pollination, i.e. only a few pollen grains on the stigma, is used. The explanation of this probably lies in the ovules, as the effect is more marked when the seed-parent carries the recessive characters. Dr. Bond thinks he also gets evidence that the functional ovules in flowers on different parts of the plant bear somewhat different proportions of the dominant and recessive factors. Such results are to be expected with a more detailed knowledge of the physiology of the ovule and pollen development in the plant.

SPONTANEOUS COMBUSTION OF HAYSTACKS.—The losses to agriculture due to the spontaneous combustion of haystacks prove to be considerable. In *Matériaux pour l'étude des calamités* for July-September 1926, Mr. G. Laupper goes into the problem at length and shows from statistics drawn from Switzerland and Germany that such fires are commonest after a good hay season and are least frequent in poor hay years. The monthly incidence also shows a clear maximum in July and August, with high figures for October and November. The summer maximum he associates naturally with the initial high temperature of the hay after its thorough exposure to solar rays before and after being made into ricks, while a good hay season means that the hay is rich in hydrocarbons, the decomposition of which is at the root of the trouble. The yearly loss to agriculture through stack fires in Germany is calculated to be about one million pounds and in Switzerland to be little less. No sure means of prevention have been discovered. Layers of straw or salt in the ricks have been proved valueless, and ventilation is not a certain cure. The only measure that can be recommended is spreading the hay as soon as abnormal temperature is noticed.

THE SURVEY OF INDIA.—The General and Map Publication Reports of the Survey of India for 1925-26 have been published. The total area of new surveys of all kinds completed during the year was 42,489 square miles. About 45 per cent. of the total area assigned to the department has now been surveyed. Work for the new geodetic level net of India made steady progress. Tidal observations were continued

as in past years. Map publication included five new sheets of the one-million map of India and adjacent countries, which is now nearing completion except for Arabia; twenty-seven new 'degree' sheets, sixty-nine half-inch and 127 one-inch sheets. The modern topographical map of India thus grows steadily, though only a little more than one-third of the total number of sheets have yet been published. The reports contain full index maps to the sheets available.

SIZE AND FIGURE OF THE EARTH.—Newton's theory of gravitation was held up for several years on account of lack of accurate knowledge of the size of the earth, and Newton himself first estimated the earth's figure from its speed of rotation. The determination of the size and figure of the earth has during the last two centuries exacted enormous labour from geodesists. It is generally assumed that the earth is approximately an ellipsoid of revolution, so that only the equatorial radius and the flattening have to be determined. Observations made in different regions of the globe are, however, rather discordant, the differences amounting to several parts in 100,000 as to the size and about 1 per cent. in the flattening. The labour which the observations have involved is so great that every effort should be made to make the fullest use of them. One difficulty in utilising the separate arcs which have been measured results from the fact that they have been discussed with respect to different figures. The figure of Clarke (1880) suits the European observations well, but a considerably different figure was deduced by Hayford from American observations, and this latter was adopted at the Madrid meeting of the Union of Geodesy and Geophysics as the reference figure for future calculations. To simplify comparisons, particularly with Clarke's spheroid, accurate tables have been computed for the Royal Geographical Society, and by means of these Mr. A. R. Hinks has discussed the principal geodetic surveys. He shows the impossibility of separating the two unknowns from arcs near the equator, and shows that different arcs fit different spheroids, and that those in India and South Africa do not fit any spheroid well. The difference in the results cannot arise from errors in the geodetic observations, but the astronomical observations may be effected to a considerable extent by local attraction, as in India. The probability is, however, that the approximation of the earth to a spheroid is only rough. Mr. Hinks points out that gravity observations can also be treated by a graphical process, and that they likewise indicate departure from a common spheroid when different regions of the earth are considered.

HELIUM CONTENT OF JAPANESE MINERALS.—On heating certain minerals containing helium, approximately 50 per cent. is evolved, and the method has been used by J. Sasaki to determine the helium contents of some Japanese minerals. The gases obtained by heating the powdered substances in an evacuated quartz-glass tube are passed over solid potash, red-hot copper oxide, and soda-lime to remove carbon dioxide and hydrogen. By sparking with oxygen in a eudiometer, nitrogen is converted into nitric oxide, which is absorbed by moist potash floating on the surface of the mercury, and the excess of oxygen is allowed to combine with melted phosphorus. The remaining impurities are removed when the residual gas is subjected to a discharge in a modified Geissler tube with liquid electrodes of a sodium-potassium alloy, and to the action of charcoal cooled in liquid air. Estimates of the geological ages of two of the minerals have been calculated by

Rutherford's method and appear together with the other data in the December issue of the *Bulletin of the Chemical Society of Japan*. The figure for monazite is 90 million years, and that for fergusonite 150 million years.

MAGNETIC ELEMENTS IN THE UNITED STATES.—The United States Coast and Geodetic Survey has recently issued two small pamphlets (Nos. 353, 360, price 10 cents each), one detailing the results of magnetic observations by the Survey during 1925, the other giving a chart, for the whole of the United States, of magnetic declination and its secular change per year, for the epoch 1925. The Survey issues such isogonic charts and secular-change data every five years, suitable stations being reoccupied during the intervening periods, in order to obtain the data necessary to carry the charts forward. With the chart is a full explanation of its construction and use to surveyors, also instructions to enable a surveyor to determine the declination with the aid of a compass and observations of the sun or stars. Tables are given for use in connexion with such celestial observations, and also tables of secular change in declination for a large number of stations, at intervals from 1750 to 1925. The first pamphlet (No. 353) gives observations of declination, dip, and intensity at respectively 330, 123, and 121 stations, widely scattered throughout the States, and including also some in the Philippines, Greenland, and the Aleutian Islands.

INDOOR ELECTRICAL ILLUMINATION.—It was stated by Mr. J. W. T. Walsh, of the National Physical Laboratory, in a paper on illuminating engineering which he read to the Institution of Electrical Engineers on Mar. 3, that 90 per cent. of the people in Great Britain carry on their work after daylight hours by an inadequate illumination and an unsuitable system of lighting. To quadruple the illumination and distribute it properly would result in better health and higher efficiency. The sources of illumination used in the early days cast unpleasant shadows. To get over this defect the indirect system of lighting, in which all the light from the source was reflected upwards to the ceiling and was then diffused over the room, was devised. The result was an almost complete absence of shadow, which, although suitable for a few special purposes, such as drawing-office work, was found to be most inconvenient for other work, such as sewing, where the shadows cast by the individual threads are a help. As a consequence of this defect, the modern semi-indirect system of lighting has been evolved. In this system part of the light is transmitted downwards through a bowl of diffusing material, while the remainder is emitted upwards to the ceiling as in the indirect system. The author considers that each of the three systems has its own field of usefulness. He thinks that in a lecture theatre, the totally indirect system has a tendency to appear lifeless and gloomy even though the amount of the illumination is ample. Some direct sources of light ought therefore to be provided in addition. The reflexion of a bright source of light from a polished surface or from a glossy paint or enamel often causes an objectionable glare. Methods should always be devised to obviate this.

ELECTRICITY SUPPLY.—In the *Journal of the Institution of Electrical Engineers* for March, Mr. J. R. Beard gives a report of the progress made in the transmission and distribution of electricity during the past year. He mentions that for many years the installation of transformer substations out-of-doors has been common abroad, and now, owing to the

high cost of buildings, it is becoming common in Great Britain. Until recently all substations for converting from alternating to direct current were manually operated. Owing mainly to the increase in the rates of wages, automatic apparatus for starting up, shutting down, and controlling the apparatus in these stations is now largely used. Experience has shown that automatic control gives greater security than manual control. A recent development is 'supervisory control,' in which the operation of a number of automatic substations can be regulated from a central control point. This combines the accuracy of automatic control with the intelligence of manual control. All the substations on the 170-mile 3000-volt main line electric railway in Natal are operated automatically. Mr. Beard mentions one curious fact in connexion with low-voltage supply in Great Britain and the United States, namely, that while a pressure of about 230 volts is general in the former, a voltage of 115 is used in the latter. The reason seems to be that in the early days the life of the low-voltage lamps was much longer and their efficiency was much higher than that of high-voltage lamps. It is almost the universal custom in America for the supply authorities to supervise and maintain consumers' lamps. In Great Britain this is left to the consumer. Twenty years ago the low-voltage lamps were much cheaper to maintain, and so the over-all efficiency with their use was greater than that with high-voltage lamps. This, combined with the cheaper wiring systems used, explains why 115 volts is still the standard pressure in the United States. Mr. Beard sums up in favour of alternating current distributed in the three-phase four-wire system.

DOPES AND DETONATIONS.—A second communication from the Air Ministry Laboratory by Prof. H. L. Callendar and collaborators, dealing with the effect of antiknock compounds on engine 'knock,' appeared in February issues of *Engineering* (pp. 147, 182, 209). The previous report (Reports and Memoranda, No. 1013) led to the conclusions that detonation was due to the presence of nuclear drops in the charge in the cylinder during explosion, and that 'antiknock' concentrated in the drops, decomposed and protected them from oxidation by the formation of a metallic film or, in the case of the organic dopes, by dilution with a substance of high critical temperature. Such an explanation being inadequate to explain the different behaviour of various dopes, the present communication extends the work on the chemical side. It is found that detonation in paraffin fuels and ether is due to the accumulation of peroxide in the nuclear drops during rapid compression. The amount of peroxide formed would not in itself be sufficient to cause the detonation observed, but acts as a primer causing simultaneous ignition of the drops. The metallic dopes are considered to act by reducing the peroxides as fast as they are formed, preventing their accumulation, and thus delaying the ignition of the drops. The processes of slow combustion of various fuels are investigated by observing the temperature at which combustion becomes appreciable, the dopes being shown in this way to delay oxidation by preventing peroxidation of the fuel. A striking experiment is described, showing the difference in the kind of ignition obtained when the vapour of paraffin is ignited in a hot tube as compared with paraffin spray. In the former case the vapour burns with a quiet flame; in the latter the mixture burns with slight explosions and flashes of flame. The present communication adds to our knowledge of the behaviour of combustible mixtures.

Light and Growth.

THE action of light on plants has had a perennial interest for plant physiologists, and recently the subject has received some concentrated attention. Ferdinand Hercik (*Publications de la Faculté des Sciences de l'Université Masaryk*, No. 74, 1926) has tried to correlate the action of light and the surface tension of the expressed sap of his plants. He finds that the sap of normally grown seedlings of *Lupinus*, *Sinapis*, and *Pisum* has a greater surface tension than sap from stems of etiolated seedlings. On the other hand, sap from leaves of normally grown seedlings has a smaller surface tension than sap from leaves of etiolated seedlings. Now etiolated plants have usually greater stem growth and less leaf growth than normal plants, and the author correlates the greater surface tension with less growth and the smaller surface tension with greater growth. If, however, seedlings have the same length, then the surface tension of their respective saps is the same irrespective of the conditions under which they have been grown. The author has not traced the causal chain between the surface tension of the sap and the actual phenomena of growth.

In a series of papers in the *New Phytologist* (vol. 24, 5, and vol. 25, 3 and 4), Prof. J. H. Priestley deals with the problem from a slightly different viewpoint and advances some tentative explanations of his results. In the case of the broad bean (*Vicia Faba*) he was able to destroy some of the more marked etiolation phenomena by only very brief exposures to light—two minutes in every twenty-four hours. He points out that any change produced on etiolated plants by the action of light must be initiated, not by the effects of photosynthetic products, but by the photocatalytic effect of light upon the products of metabolism. For example, cells from the cortical region of an etiolated broad bean tip are incapable of being plasmolysed in a 17 per cent. cane-sugar solution, but, after exposure to artificial light for one hour on two successive days, are plasmolysed readily. The author considers that the photochemical action of light releases protein and fatty substances from the developing walls of the cells intervening between the central cylinder and

meristem; and these walls, now consisting of purer cellulose, readily permit of the transfer of the nutrient sap from the central cylinder, with an ensuing more diffuse and more superficial development of meristematic tissue. In this way growth, which in the etiolated plant is confined to tips of stems, becomes redistributed.

The phototropic curvature of grass and cereal coleoptiles, the subject of much experimentation, is explained by Prof. Priestley on the basis of the foregoing hypothesis. Thus the side of the coleoptile exposed to the light becomes in consequence more permeable, with greater guttation through the apical hydathode from the vein nearer the light. The cells of the lighted side will therefore extend in length less than those of the darkened side, producing a curvature towards the light.

Following still another line of attack, Prof. Y. Yoshii has experimented on the influence of the relative length of day and night on plants (*Science Reports of the Tôhoku Imperial University*, 4th series, vol. 2, 2). His results, in the main, confirm and extend the work of Garner and Allard in grouping plants into two categories, long and short day plants, according to the length of daily illumination necessary for the production of flowers (*Jour. Agri. Res.*, 18, p. 553, and 23, p. 871). The evidence adduced leads to the conclusion that there is probably another group of plants which are nearly or entirely indifferent to photoperiods, but affected by other factors as to time of flowering. The author finds that the optimum photoperiod for reproduction does not result in maximum vegetative growth, and that closely related plants, sometimes even varieties of the same plant, may behave quite differently as regards photoperiods; for example, the late variety of rice plant is a short day plant, while the early variety is indifferent to regulation of light period. This seems to suggest that some other factors besides those concerned in photosynthesis are involved. If the photoperiod is the key to the distinction between spring and winter varieties of wheat, then researches along this particular line may have some application in the practical field of crop production.

Yorkshire Ammonites.¹

THE amateur geologist who collects Yorkshire ammonites may approach the collection of papers before us with expectation, but he is likely to be disappointed if he hopes to identify his specimens from the descriptions there given. The work is not for the amateur, but for the specialist; and even he will have to dig deep in involved sentences to find the information which only so patient and expert a worker as Dr. Spath can give. These little papers have really an immense scope, gathering up and pronouncing upon outstanding uncertainties in the systematics of the main groups to which belong all ammonites commonly found in the Lower Lias; supplying new generic names where needed; and tilting at the evolutionary conceptions of previous ammonite workers.

To promote the first aim, Dr. Spath appeals to Yorkshire geologists to go into the field and collect Yorkshire ammonites bed by bed. In proposing new generic names, he considers that the quotation of a genotype is sufficient diagnosis. That would be more justifiable if the genotype were a species known by

an existing holotype, and not mainly or merely by a figure. It is also probable that ammonite specialists the world over will miss the new genera thus casually proposed in notes on a local fauna in a journal which caters for amateur naturalists rather than professional palæontologists.

The fact is that Dr. Spath has tried to pack into these modest papers matter far beyond their scope, and he has condensed it almost to the limits of intelligibility. We feel that he could expand his remarks on evolution into an enthralling thesis, but here we can catch only the barest outline of his scheme. He has nothing but scorn for those who find comfort in supposed ammonite lineages, but he does not give them instead a clear-cut theory of evolution. The following points, however, seem to stand out: (1) The two great families, namely, Phylloceratidæ and Liparoceratidæ, persisted almost unchanged throughout the Mesozoic, and were the radical stocks whence group after group repeatedly sprang, rapidly evolved in many directions, and quickly died out. (2) Already in Triassic time all possible forms of ornament and whorl-shape had been tried, only to reappear again and again in later stocks (we must not say lineages). This seems to support

¹ Hull Museum Publications, No. 143. "Notes on Yorkshire Ammonites." By Dr. L. F. Spath. Reprinted from the *Naturalist* for April-July, Sept.-Dec., 1925; Feb., May, June, Sept., Nov., 1926.

a doctrine of Trends. (3) Even within a single species the young show very great variability, and on reaching maturity converge to a common form, thus refuting, in Dr. Spath's opinion, the doctrine of post-embryonic recapitulation. (4) New characters often appear first in the young, again proving that the doctrine of post-embryonic recapitulation is unsound. All these evolutionary pronouncements are of great interest, and would bear critical consideration, but here they can only be noticed, not discussed.

University and Educational Intelligence.

BRISTOL.—The following appointments have been made: In the Department of Chemistry, Dr. W. E. Garner, University College, London, to be professor of physical chemistry in succession to Prof. J. W. McBain, and Dr. Morris W. Travers, to be reader in applied physical chemistry and an honorary professor of the University. In the Department of Physics, Dr. J. E. Lennard-Jones, reader in mathematical physics, to be professor of theoretical physics; Dr. H. W. B. Skinner to a Henry Herbert Wills research fellowship in physics. Dr. L. C. Jackson was also appointed to a Henry Herbert Wills research fellowship some time ago.

It is hoped that the building of the Henry Herbert Wills Physics Laboratory will be completed in the summer, and that it will be ready for use by the beginning of next session.

CAMBRIDGE.—Field-Marshal Sir William Birdwood has been elected to an honorary fellowship at Peterhouse, a College with which he is closely connected by family ties.

R. O. Redman, St. John's College, has been elected to the Sheepshanks Exhibition in astronomy at Trinity College. The subject for the Adams Prize for the period 1927-28 is announced as "The Variations in the Earth's Magnetic Field in Relation to Electric Phenomena in the Upper Atmosphere and on the Earth." A theoretical contribution to the origin of the various phenomena and their qualitative and quantitative relations with each other is asked for.

LONDON.—The following Doctorates have been conferred: D.Sc. in statistics on Mr. E. C. Rhodes (University College) for a thesis entitled (1) "On a Skew Correlation Surface," (2) "The Precision of Means and Standard Deviations when the Individual Errors are correlated," (3) "The Comparison of Two Sets of Observations"; D.Sc. (Engineering) on Mr. W. H. J. Vernon (Imperial College—Royal School of Mines) for a thesis entitled "The Atmospheric Corrosion of Metals (Second Experimental Report to the Atmospheric Corrosion Research Committee)."

MANCHESTER.—Dr. Alex. M. Smith has been appointed lecturer in agricultural chemistry and adviser under the Ministry of Agriculture advisory scheme.

THE Ella Sachs Plotz Foundation has issued its third annual report, from which it appears that thirty-eight applications for assistance in 1926 were received. Thirteen grants were made, seven of them to scientific workers outside the United States. For the present, research on problems in medicine and surgery is favoured, and preference is given to a group of investigations on a single subject; for example, four grants have been given each year for work bearing on the subject of chronic nephritis. Applications for grants for 1927-28 should be sent to Dr. Francis W. Peabody, Boston City Hospital, Boston, Massachusetts, before May 15.

Calendar of Discovery and Invention.

April 10, 1864.—The modern process of manufacturing open hearth steel was started by Pierre-Emile Martin, who melted together pig-iron, scrap, and iron ore in a Siemen's regenerative furnace. Martin's French patent was taken out on April 10, 1864. Two hundred years ago, Réaumur described the conversion of wrought iron into steel by fusing it with pig-iron, but his experiments never went beyond the laboratory stage. The open hearth process was introduced into America in 1868. In 1880 that country produced 1,074,000 tons of Bessemer steel, and 110,000 tons of open hearth steel. Forty years later these figures had increased to 8,883,000 tons of Bessemer steel, and 32,672,000 tons of open hearth steel, the total production being nearly equal to half a ton of steel per head of population.

April 11, 1709.—The most famous of all prizes for scientific work is the Copley Medal of the Royal Society. It was founded by Sir Godfrey Copley, Bart., who by his will dated Oct. 14, 1704, and proved April 11, 1709, bequeathed to Sir Hans Sloane and Abraham Hill "one hundred pounds in trust for the Royal Society of London for improving natural knowledge, to be laid out in experiments or otherwise for the benefit thereof as they shall direct and appoint." No award was made until 1731, when Stephen Gray, an inmate of the Charterhouse, received a prize for his electrical experiments. On Nov. 10, 1736, the Royal Society resolved to convert the bequest into a gold medal, Desaguliers receiving the first, and since then the medal has generally been awarded annually. Copley was a member of Parliament and held various public offices. In 1881 he then representative of the family, Sir Joseph Copley, transferred to the Royal Society a sum in Consols sufficient to provide in perpetuity an annual bonus of £50 to be given to the recipient of the medal (v. also NATURE, Dec. 4, 1926, p. 823).

April 13, 1869.—The successful braking of trains was first solved by Westinghouse. A head-on collision between two trains directed his attention to the matter, and the chance reading of an account of the use of compressed air in boring the Mont Cenis Tunnel led to his experiments with an air brake. His first steam-air brake was patented on April 13, 1869. In 1872 he described the automatic brake, and the following year brought out his ingenious triple valve. In the famous trials on trains carried out by Sir Douglas Galton in 1878-9, the brake of Westinghouse proved its superiority, but it was afterwards much improved, Westinghouse alone taking out altogether 103 patents in connexion with it.

April 15, 1777.—A hundred and fifty years ago, in a letter dated April 15, 1777, Volta suggested to Prof. Barletti of Pavia the possibility of firing a pistol at Milan by the discharge of Leyden jars at Como, the two places being joined by an iron wire.

April 15, 1845.—Liebig is regarded as the virtual founder of agricultural chemistry. His famous work, "Die organische Chemie . . ." appeared in 1840, and it was on a barren plot of land outside Giessen that he made his experiments. His researches also led to the foundation of the artificial manure industry, and he himself, through James Muspratt, on April 15, 1845, took out an English patent, the object of his invention being "to restore to the land by means of a manure the mineral elements taken away by the crop which had been grown on and removed from the land."

April 15, 1893.—The finest pre-turbine British liner was the s.s. *Campania*, which on April 15, 1893, developed 31,050 h.p. and attained a speed of 23.18 knots, her displacement being 18,000 tons. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Mar. 31.—Sir Robert Hadfield: Alloys of iron and manganese of low carbon content. The range of alloys covers 0.06 per cent. to 38.90 per cent. manganese, also one additional alloy containing 83.50 per cent. manganese. With 4.00 per cent. to 10.00 per cent. manganese the alloys have a comparatively high Brinell hardness, in the region of 400, and are brittle; from 15.00 per cent. to 39.00 per cent. manganese, characteristics are observed similar to those of manganese steel, though only to a limited extent—that is, a comparatively low Brinell hardness, in the neighbourhood of 200, with considerable tenacity and ductility and fair capacity for work-hardening. The alloy containing 83.50 per cent. manganese is hard, brittle, and unforgeable. With 16.00 per cent. or more of manganese the alloys are non-magnetic, whereas in the presence of 1 per cent. of carbon not more than about 7 per cent. manganese is required to take away or suppress the magnetic qualities of the iron. The electrical resistance, while increasing with manganese percentage up to 87.2 microhms per cubic centimetre for the 38.90 per cent. alloy, does so in a fairly continuous manner and without any changes of a critical character such as those observed for the specific magnetism. In their corrodibility the alloys show under some conditions a somewhat improved resistance as compared with ordinary steel, but not such as to make them of any practical value in this connexion. In their micro-structure the alloys with increasing manganese percentage pass at 4 per cent. from a pearlitic structure to a martensitic, which at about 16 per cent., that is, the point where almost completely non-magnetic qualities appear, changes into the austenitic type.

E. Griffiths: The thermal and electrical conductivity of a single crystal of aluminium. A method is described for the determination of the thermal conductivity which does not necessitate any machining of the crystal. Tests were made at various temperatures, the value of the thermal conductivity at 100° C. being 0.55 C.G.S. units. The specific electrical resistivity is 2.89×10^{-8} ohms per centimetre cube at 18° C.

W. L. Webster: The transverse magneto-resistance effect in single crystals of iron. The change of resistance of single crystals of iron produced by a transverse magnetic field has been investigated. Measurements were made with the current along a {100}, {110} or {111} crystal axis, and with the field in a series of positions in the plane normal to these directions. The phenomenon is of a double nature. There is in all cases a gradual decrease in resistance approximately proportional to the field, and probably due to the action of the field on the conducting electrons. Superimposed on this effect there is a sudden change in resistance between 5000 gauss and 12,000 gauss, the sign depending on the direction of the current and the magnitude on the direction of the field. This second effect is probably caused by the change of orientation of the atoms accompanying magnetisation.

W. A. Bone, R. P. Fraser, and F. Witt: The initial stages of gaseous explosions. Part iii. The behaviour of an equimolecular methane-oxygen mixture when fired with sparks of varying intensities. Sparks of varying intensities were passed between electrodes fixed half-way along a horizontal glass tube (35.50 cm. long by 2.2.5 cm. diameter), both ends of which were closed in one series of experiments but open in another. The new evidence, which mainly lies in the photographs taken, shows (a) the occurrence, under ordinary sparking conditions, of what seems to

be a definite 'induction period' as a preliminary to the actual combustion; (b) initial propagation through the medium of a 'ghost-like flame' condition involving only a very partial combination of the gases; and (c) the main combustion, following later as the result of the superposing of a compression wave, or the like, upon a system which during the phase (b) has already become highly sensitive to chemical changes.

F. T. Meehan: The expansion of charcoal on sorption of carbon dioxide. Wood charcoal expands when it sorbs carbon dioxide, and the process is reversible. The relations between expansion, pressure and temperature are similar to those connecting quantity of gas sorbed with pressure and temperature. Thus at constant temperature the expansion is related logarithmically to the gas pressure; at constant pressure the expansion is inversely proportional to the temperature. The same relations hold above and below the critical temperature of carbon dioxide. As the expansion is uniform in the three original grain directions, it appears that carbonisation destroys the structure of wood, leaving an isotropic product.

J. E. Lennard-Jones and W. R. Cook: The equation of state of a gaseous mixture. A theoretical formula is given for the equation of state of a gaseous mixture, and from it is deduced a generalisation of Dalton's partial pressure law. The forces between the unlike molecules of a mixture can be deduced.

Aristotelian Society, Feb. 21.—A. Wolf: Some aspects of the philosophy of Spinoza. The paper dealt with some common misinterpretations of Spinozism. The chief of these are (1) the quasi-Kantian interpretation of the Attributes as subjective ways of regarding Nature, instead of as objective characters of Nature; (2) the mistranslation of *infinite* attributes by *innumerable* attributes, instead of simply "all the Attributes," which may not exceed the two known to man, namely, extension and thought; and (3) the logico-mathematical, instead of the dynamic, interpretation of the attributes in relation to finite objects. The last was specially emphasised, as it obscures the relation of Spinoza to the science of his time and of ours. Reality for Spinoza was essentially activity, energy. Spinoza criticised Descartes' conception of matter as mere extension, saying that from such inert matter the world of physical phenomena could not be derived. For Spinoza matter was essentially energy occupying space. The inert idea of matter had eventually to be abandoned, and, in spite of Newton's protest, matter came to be regarded as kinetic of its own nature, so as not to need an external mover. Similarly with Spinoza's conception of thought; ideas, he insisted, are not dumb pictures on a tablet, but active assertions. While European psychology was for many generations obsessed with the conception of mind as a passive tablet on which sense stimuli make impressions, Spinoza already anticipated present-day dynamic conceptions in psychology, as he anticipated the general kinetic conceptions of physics.

Geological Society, Feb. 23.—W. D. Lang and S. Smith: A critical revision of the rugose corals described by W. Lonsdale in Murchison's "Silurian System." These forms include some of the earliest-described British Silurian forms. A detailed examination has been made of their external characters and the internal structure with the object of putting the nomenclature upon a sound footing.—L. G. Anniss: The geology of the Saltern Cove area (Torbay). The series here termed Red Shale Group (Upper Frasnian and Lower Fammenian) are overthrust on the north

by the Staddon Grits and Shales (Upper Coblentian), and on the south by the 'Massive Limestone' (probably Lower Frasnian). The 'Massive Limestone' forms the high ground on the south and also the summit of Sugar Loaf Hill, between which denudation has cut a deep valley exposing the Upper Devonian as a 'window.' The latter is a series of Red Shales, thin limestones, and tuffs. From these beds goniatites have been collected, which fix the fossiliferous horizon on Zone 1 γ of Wedekind. Associated with the Upper Devonian is a decomposed albitedolerite; this rock has no connexion with the intrusions of the Torquay and Dartmouth areas, but is comparable with those of the Ashpington and Totnes areas.

Association of Economic Biologists, Feb. 25.—F. Tattersfield and C. T. Gimmingham: During laboratory and field experiments on contact insecticides, an apparatus and technique have been devised for the quantitative study of the toxicity of contact insecticides, both to adult insects and to insect eggs, and some relationships between chemical constitution and toxicity in certain groups of synthetic organic compounds have been worked out. The results of the laboratory work have led to experiments in the field with certain compounds, highly toxic to insect eggs, which may prove to have practical value for winter spraying. The toxic properties of extracts of some tropical plants have also been studied.

Society of Public Analysts, Mar. 2.—E. Richards Bolton (Presidential address). The new preservatives regulations were welcomed. The adulteration of food is steadily decreasing, partly owing to the activity of the authorities, and partly to the efficiency of public analysts. Manufacturers should avail themselves of the services of a chemist to maintain the purity of their products and advise them in order to enable them to avoid any contravention of the law. The food of Great Britain was never in a purer state than it is at the present time.—A. W. Knapp, J. E. Moss, and A. Melley: Cacao butter substitutes and their detection. The most useful single test is the determination of the 'titre' of the fatty acids, and in the absence of certain other fats (e.g. coconut oil) this test enables the amount of Borneo tallow in admixture with cacao butter to be approximately determined after reference to a curve. A new method of determination has been based on the fact that the green colour of Borneo tallow is not bleached by ultra-violet light, whereas the yellow colour of cacao butter is readily bleached.—H. W. Bywaters, F. T. Maggs, and C. J. Pool: The determination of illipé butter in chocolate. Melted illipé butter becomes turbid at a much higher temperature than cacao butter, and the turbidity temperature determined under definite conditions is practically constant for different specimens of the two fats. If a third fat (e.g. milk fat) is also present, the percentage of illipé butter may still be found by reference to a curve, provided that the amount of the third fat can be ascertained.—A. F. Lerrigo and A. L. Williams: A study of the determination of saccharin, colorimetrically and by the ammonia process (work done under the Analytical Investigation Scheme). None of five colour reactions of saccharin studied under variable conditions gives quantitative results. The ammonia process (in which saccharin is converted into the ammonium salt of sulphobenzoic acid, the ammonia in which is determined by distillation) has been adapted to the determination of small quantities of saccharin.

Linnean Society, Mar. 3.—A. J. Wilmott: The Irish *Spiranthes* called *S. Romanzoffiana* Cham. Specimens

from County Cork and Lough Neagh are distinct; the southern one is *S. gemmipara* Lindl., and the northern one *S. stricta* Rydberg.—J. Davidson: On the occurrence of intermediates in *Amphis rumicis* L. and their relation to the alate and apterous viviparous females. In *Aphis rumicis* L. (Hemiptera, fam. Aphididae) both alate and apterous viviparous females (virginoparae) develop in the parthenogenetic generations. The alate forms tend to produce apterous forms, and the apterous virginoparae produce only apterous forms or a mixed progeny of apterous and a variable percentage of alate forms. From time to time intermediate individuals develop. Compared with their immediate alate and apterous relations in the same generation, these intermediate forms behaved as apterous forms.

EDINBURGH.

Royal Physical Society, Feb. 21.—Isobel Deans: The genus *Hicksonia*: an account of a new species. A new species, *Hicksonia kollikai*, is described. Attention is directed to the occurrence of telestid-like spicules which suggest the derivation of telestids from clavulariids.—D. Chalmers: Worm parasites of common marine fishes. The results of an examination of specimens of sixteen species of North Sea fishes. Thirty-one species of parasitic worms are described, including three new, or hitherto unrecorded in the present host.—C. Cumming: Re-investigation of the eye of the mole. Embryonic development and histological structure of the eye of the mole are described. The whole of the eye shows a simplification. The lens is degenerate, the retina partly so; normal image perception is impossible.

PARIS.

Academy of Sciences, Feb. 28.—S. Winogradsky: Researches on the degradation of cellulose in the soil. Hutchinson and Clayton, in 1919, isolated the first typical representative of the group of aerobic bacteria attacking cellulose, and the author has followed the same general method. A dozen forms have been isolated falling in two groups, Cytophaga, the type discovered by Hutchinson and Clayton, and vibrios. In the latter group, the fibrolytic action is much less marked than with the Cytophaga, but they spread over paper with great rapidity.—A. Weinstein: A problem at the limit in an indefinite band.—Paul Lévy: The iteration of the exponential function.—G. Pólya: The singularities of the lacunar series.—D. V. Jonesco: A class of functional equations.—C. Cerf: The integration of systems in involution of partial differential equations.—Mandelbrojt: A complement to the theorem of M. Fatou.—G. Sugot: The integration of the differential equations of the gyroscopic movement of a projectile.—Kolosoff: A transformation of the equations of elasticity.—J. Vorobeitchik: The horizontal flight of an aeroplane with great radius of action.—J. Thovet: The propagation of aerial waves in large subterranean cylindrical mains. The proved lack of uniformity of temperature in large underground mains will tend to give low values for the velocity of sound in such tubes. It would appear to be impossible to apply a suitable correction.—Belin and Holweck: Television. First results in the transmission of moving images.—J. Cabannes and P. Daure: The absolute measurement of the intensity of the light diffused by benzene in the liquid state. On the basis of measurements on the light diffused by benzene and other liquids, the authors conclude that it is not at present possible to deduce the Avogadro number from measurements of the diffusion of light by liquids.—Pierre Jolibois, Henri Lefebvre, and Pierre Montagne: The chemical yield in the decomposition

of carbon dioxide under small pressure by the condensed spark. The experimental results cited agree with the theoretical conclusions deduced from the study of the thermal dissociation of carbon dioxide. The energy of the electrical discharge is only partially utilised in the form of chemical energy, and the figures expressing the yield are notably lower than those calculated on the supposition that the spark produces in the gas uniquely a heat development absorbed quantitatively by the gas.—Albert Kirmann: A method of synthesis of α -bromoaldehydes. The general method proposed is the action of phosphorus chlorobromide, PCl_2Br_2 , on the acetals $\text{R} \cdot \text{CH}_2 \cdot \text{CH}(\text{OR})_2$. This reaction gives the α -bromoaldehyde $\text{R} \cdot \text{CHBr} \cdot \text{CHO}$ together with RBr , HBr , phosphorus trichloride and oxychloride. The method is practicable starting from C_4 , and gives good yields above C_5 . The physical properties of five bromoaldehydes prepared by this method are given.—Paul Gaubert: The formation in the insoluble state of two hydrates of magnesium platinocyanide.—Ch. Gorceix: The variation of longitudes can be attributed to another cause than the drift of the continents.—C. E. Brazier: The periodicity of the magnetic disturbances observed at Parc Saint-Maur and at Val-Joyeux. The results of a statistical analysis of 36 years' observations tend to show that the days on which there are magnetic disturbances succeed each other at intervals of which the approximate duration will be equal to one of the numbers obtained by multiplying the period of synodic rotation of the sunspots by a simple fractional factor, between 0.5 and 3.—R. Combes: The nitrogen in a ligneous plant in the course of a year's growth.—Volmar and Samdahl: The constitution of α -kirondrine. Owing to the small quantity available for study the constitution of α -kirondrine could not be completely determined. It is a bitter toxic principle which is neither an alkaloid nor a glucoside but a lactone containing one or more aldehyde groups.—A. Demolon and G. Barbier: Study of the mechanism of the exchanges of ions in the clay-lime complex.—A. Rochon-Duvigneaud and M. L. Verrier: The existence of serous pockets in the orbit and in the eye of the teleosts.—Béhague, Garsaux, and Charles Richer, jun.: The rhythm and respiratory frequency of animals submitted to a barometric depression.—Pierre Lesne: The subfossil *Gyrinus* of Belle-Isle-en-Mer.—Armand Dehorne: The annual reproductive cycle of *Dodecaceria concharum* at Le Portel.—Louis Bounoure: The primary gonocytes in the embryos of toads from eggs submitted to uterine super-maturation.—A. Fernbach, M. Schoen, and Motohichi Mori: Some observations on the so-called elective fermentation. It has been held that the differences in the velocity of disappearance of various sugars in a mixture was due to differences in the resistance that the cell-wall of the living yeast offered to the passage of the various sugars. It is now shown that these differences do not depend on the presence of the living yeast, but are also shown by zymes prepared according to the technique of Albert, Buchner, and Rapp. The causes of this selection still remain obscure.—A. Marxer: The proteolytic ferment of *Bacillus subtilis*.—Maurice Letulle and Louis Vinay: Experimental cancer of the lung.

VIENNA.

Academy of Sciences, Jan. 27.—F. Holzl: The alkylation of ferrocyanic acid.—R. Frisch: The action of slow cathode rays on rock-salt.—H. Küpper: Elucidation of morphogenesis and tectonics at the edge of the Vienna basin.—A. Smekal: The coloration of rock-salt crystals by radium radiation.

Official Publications Received.

BRITISH.

- The Preservation of Ancient Cottages. An Appeal by the Rt. Hon. Stanley Baldwin; with a Note by Thomas Hardy. Pp. 16+5 plates. (London: Royal Society of Arts.)
- Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 50: On the Freezing Mechanism of a Mysel Crystalline, Homomy's Lamore. By Dr. H. Graham Cannon and Miss S. M. Matton. Pp. 30+253+4 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 6s.
- British Museum (Natural History). Picture Postcards. Set E43: Exotic Butterflies, Series No. 7. 5 cards in colour. 1s. Set E44: Exotic Butterflies, Series No. 8. 5 cards in colour. 1s. (London.)
- Shirley Institute Memoirs. Vol. 7, 1926. Pp. vii+349+iv. (Manchester: Shirley Institute.)
- Reports of the Progress of Applied Chemistry. Vol. 11, 1926. Pp. 742. (London: Society of Chemical Industry.)
- Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 8, Part 2, 1925-26. Pp. 110-167+XXIX-XXVIII. (Perth: Perth Natural History Museum.) 2s. 6d.
- Uganda Protectorate: Geological Survey Department. Occasional Paper No. 2: The Geology and Palaeontology of the Kairo Bone-Beds. Part 1: Geology, by E. J. Wayland; Part 2: Palaeontology, by Members of the British Museum (Natural History) Staff—Mammalia, by Arthur T. Hopwood; Reptalia, by W. E. Swanton; Peces, by Erol Ivor White; Mollusca, by L. R. Cox. Pp. 71-9 plates+2 maps. (Entebbe.) 6s. 6d.
- The Physical Society. Proceedings, Vol. 8, Part 2, February 17. Pp. 10-170. (London: Fieldway Press, Ltd.) 6s. net.
- Nigeria. Fifth Annual Bulletin of the Agricultural Department, 1st Aug. to 1926. Pp. 254. 8s. Annual Report on the Agricultural Department for the Year 1926. Pp. 15. (Lagos: Government Printer.)
- Department of Agriculture, Ceylon. Bulletin No. 77 (Bulletin No. 43, Rubber Research Scheme, Ceylon): The Inter-Relationship of Yield and the Various Vegetative Characters in Hevea Brasiliensis. By R. A. Taylor. Pp. 67. 40 cents. Bulletin No. 78: Manuring in relation to the Control of the Shot-Hole Borer of Tea (*Acronyctus perkinsi*, Eichl.). Part 1, by F. P. Jepson; Part 2, by Dr. C. H. Gadd. Pp. 47. 40 cents. Bulletin No. 79 (Bulletin No. 44, Rubber Research Scheme, Ceylon): The Construction of Smoke Houses for Small Rubber Estates. By T. E. H. O'Brien. Pp. 7+4 plates. 40 cents. (Peradeniya.)
- The Zoological Society of Scotland. An Appeal for Funds for the Scottish Zoological Park. Pp. 40. (Edinburgh.)
- Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1924-25. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India. Pp. ii+ix+81. (Calcutta: Government of India Central Publication Branch.) 15 rupees; 2s. 6d.
- Aeronautical Research Committee: Reports and Memoranda. No. 1046 (Ae. 22): The Effects of Body Interference on Airspeed Performance. By W. G. Jennings. (A.S.D. Air-crafts, 94.—T. 220.) Pp. 8+3 plates. (London: H.M. Stationery Office.) 6d. net.
- The Journal of the Institution of Electrical Engineers. Vol. 65, No. 363, March. Pp. 297-368+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.
- The Journal of the Quekett Microscopical Club. Edited by W. S. Warton. Ser. 2, Vol. 13, No. 92, February. Pp. x+211-288. (London: Williams and Norgate, Ltd.) 8s. 6d. net.
- Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1925-26. (Cmd. 2782.) Pp. iv+178. (London: H.M. Stationery Office.) 8s. net.
- Ministry of Health. Reports on Public Health and Medical Subjects, No. 87: A Report on the Occurrence of Glass Fragments in Foods packed in Glass Containers. By George C. Hancock. Pp. iv+96 (15 plates). (London: H.M. Stationery Office.) 1s. net.
- British Research Association for the Woollen and Worsted Industries. Annual Report, 1926. Pp. 23. (Huddersley, Leeds.)
- Memoirs of the Geological Survey of India. Palaeontologia Indica. New Series, Vol. 7, Memoir No. 8: A Review of the Genus *Gisortia*, with Descriptions of several Species. By E. Viedenburg. Pp. iv+124+32 plates. (Calcutta: Government of India Central Publication Branch.)
- Report of the Department of Industries, Madras, for the Year ended 31st March 1926. Pp. iv+98+ii. (Madras: Government Press.) 12 annas.
- Forest Bulletin No. 60: The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir. By L. N. Seaman; assisted by C. R. Ranganathan. Pp. iii+26+5 plates. (Calcutta: Government of India Central Publication Branch.) 1.1 rupees, 1s. 9d.
- Canada. Department of Mines: Geological Survey. Summary Report, 1925, Part A. (No. 2113.) Pp. 348. Summary Report, 1925, Part B. (No. 2114.) Pp. 46. Economic Geology Series No. 8. The Iron Ores of Canada. Vol. 1: British Columbia and Yukon. By G. A. Young and W. L. Uglow. (No. 2093.) Pp. ii+253. 40 cents. (Ottawa: F. A. Acland.)
- Canada. Department of Mines: Victoria Memorial Museum. Museum Bulletin No. 43, Biological Series No. 11: List of Mushrooms and other Fleshy Fungi of the Ottawa District. By W. S. Odell. (No. 2088.) Pp. iii+15. (Ottawa: F. A. Acland.) 10 cents.
- University of Reading. The National Institute for Research in Dairying. Annual Report, for the Year ending 31st July 1926. Pp. v2. (Reading.)
- Report on the Health of the Army for the Year 1925. (Vol. 61.) Pp. iv+152. (London: H.M. Stationery Office.) 8s. 6d. net.
- The Institution of Professional Civil Servants. Annual Report of Council for the Year 1926. Pp. 44. (London.)
- Report of the Marlborough College Natural History Society for the Year ending Christmas, 1926. (No. 75.) Pp. 91. (Marlborough.) 5s.
- Torquay Natural History Society. Transactions and Proceedings for the Year 1925-6. Edited by the Rev. James H. Balleine and H. L. Earl. Vol. 4, Part 4. Pp. 269-386. (Torquay.)
- Report of the Rugby School Natural History Society for the Year 1926. Pp. 54. (Rugby.)

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 14, No. 3, March. Pp. 357-823. (Plymouth.) 10s. net.
The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 3, 1924-1925. Pp. xii+139+22 plates. (London: Science Museum.) 2s.

FOREIGN.

The Carnegie Foundation for the Advancement of Teaching. Bulletin No. 18: Games and Sports in British Schools and Universities. By Howard J. Savage. Pp. vi+212. (New York City.)
Proceedings of the Imperial Academy. Vol. 3, No. 1, January. Pp. ii+48. (Gend Park, Tokyo.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Special Bulletin No. 161: Varieties and Locations as Factors in Apple Production. By V. R. Gardner. Pp. 45. Circular Bulletin No. 95: How to Make and Preserve Cider. By F. W. Fawcett. Pp. 29. Circular Bulletin No. 99: House Plants. By Alex. Laurie. Pp. 18. Circular Bulletin No. 100. Michigan Farmers' Tax Guide. By R. Wayne Newton. Pp. 11. (East Lansing, Mich.)

University of Illinois Engineering Experiment Station. Bulletin No. 158: The Measurement of Air Quantities and Energy Losses in Mine Entries. By Prof. Alfred C. Callen and Cloyd M. Smith. Pp. 77. 45 cents. Bulletin No. 170: An Investigation of Twist Drills. By Bruce W. Benedict and Albert E. Hershey. Pp. 75. 40 cents. (Urbana, Ill.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 23, Part 10: The North American Species of Scutellaria. By Emory C. Leonard. Pp. viii+703-748. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution. United States National Museum. Bulletin 138: The Fossil Stalk-Eyed Crustacea of the Pacific Slope of North America. By Mary J. Rathbun. Pp. viii+155+39 plates. 50 cents. Bulletin 149: Fire as an Agent in Human Culture. By Walter Hough. Pp. xiv+370+41 plates. 50 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 784: Bibliography of North American Geology for 1923-1924. By John M. Nickles. Pp. iii+280. 40 cents. Bulletin 785-B: Topographic Instructions for the United States Geological Survey. B: Triangulation. Compiled by E. M. Douglas. Pp. ii+47-57+4 plates. 10 cents. Bulletin 785-C: Topographic Instructions of the United States Geological Survey. C: Transit Traverse. Compiled by E. M. Douglas. Pp. iv+89-116+3 plates. 10 cents. Bulletin 785-D: Topographic Instructions of the United States Geological Survey. D: Leveling. Compiled by E. M. Douglas. Pp. iv+117-160+2 plates. Bulletin 790-A: Pedestal Rocks formed by Differential Erosion and Channel Erosion of the Rio Salado, Socorro County, New Mexico. Papers by Kirk Bryan. (Contributions to the Geography of the United States, 1926.) Pp. ii+19+3 plates. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 558: Surface Water Supply of the United States, 1922. Part 12: North Pacific Slope Drainage Basins. B: Snake River Basin. Pp. vi+205+2 plates. 40 cents. Water-Supply Paper 554: Surface Water Supply of the United States, 1922. Part 12: North Pacific Slope Drainage Basins. C: Lower Columbia River Basin and Pacific Slope Drainage Basins in Oregon. Pp. v+184+2 plates. 25 cents. Water-Supply Paper 559: Relations between Quality of Water and Industrial Development in the United States. By W. D. Collins. Pp. iv+48+5 plates. 15 cents. Water-Supply Paper 565: Surface Water Supply of the United States, 1923. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. v+190+3 plates. 30 cents. Water-Supply Paper 580-B: Water Power and Irrigation in the Jefferson River Basin, Montana. By John F. Deeds and Walter N. White. (Contributions to the Hydrology of the United States, 1926.) Pp. ii+41-114+1 plate. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Forty-seventh Annual Report of the Director of the Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1926. Pp. ii+96. (Washington, D.C.: Government Printing Office.)

Middelanden från Lunds Astronomiska Observatorium. Serie 2, Band 5, No. 41-50: Festskrift tillagnad C. V. L. Charlier på hans Sextiofemårsdag den 1 April 1927 af Larjungar. Pp. 20+15+86+16+18+35+60+8+9+97+17+23+8+20+12. No. 34: Studies in Stellar Statistics. v: On the Galaxy of the B-Stars. By C. V. L. Charlier. Pp. 33+10 plates. No. 35: On the Calculation of the Characteristics of the Apparent Proper Motion Distribution of the Stars. By W. Gyllenberg. Pp. 12. No. 36: Statistical Notes on the Draper Catalogue. By C. V. L. Charlier. Pp. 36+28 plates. No. 112: Einige Bemerkungen über die räumliche Verteilung der Sterne. Von K. G. Malmquist. Pp. 7. No. 113: On the Zero Point of the Period-Luminosity Curve. By K. G. Malmquist. Pp. 7. (Lund, C. W. K. Gleerup.)

U.S. Department of Agriculture. Department Bulletin No. 1439. Fish Oil, an Efficient Adhesive in Arsenate-of-Lead Sprays. By Clifford E. Hood. Pp. 22. 10 cents. Department Bulletin No. 1476: A Progress Report on the Investigations of the European Corn Borer. By D. J. Caffrey and L. H. Worshley. Pp. 135. 85 cents. (Washington, D.C.: Government Printing Office.)

University of Washington Publications in Anthropology. Vol. 1, No. 5: Klamath Ethnography. By Erna Gunther. Pp. 171-314. (Seattle, Wash.: University of Washington Press.) 1.25 dollars.

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 7, Part 1: Plant Ecology of Porto Rico. By H. A. Gleason and Mel. T. Cook. Pp. 96+20 plates. 2 dollars. Vol. 7, Part 2: Plant Ecology of Porto Rico. By H. A. Gleason and Mel. T. Cook. Pp. 97-173+plates 21-50. 2 dollars. (New York City.)

Proceedings of the United States National Museum. Vol. 70, Art. 19: Diagnoses of Undescribed New Species of Mollusks in the Collection of the United States National Museum. By William Healey Dall. (No. 2668.) Pp. 11. Vol. 70, Art. 21: A Stony Meteorite from Forsville, Mecklenburg County, Virginia. By George P. Merrill. (No. 2670.) Pp. 4+3 plates. (Washington, D.C.: Government Printing Office.)

Contributions from the Jefferson Physical Laboratory and from the Crut High-Tension Electrical Laboratory of Harvard University for the year 1925. Vol. 18. 48 papers, not paged. (Cambridge, Mass.)

Diary of Societies.

SATURDAY, APRIL 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 8.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (4).

MONDAY, APRIL 11.

ROYAL IRISH ACADEMY, at 4.15.
ROYAL SOCIETY OF MEDICINE (War Section) (Annual General Meeting), at 4.30.—Major T. J. Mitchell: Man-power and the Medical Service in Relation to some of the Principles of War.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration of Joints.
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—T. Hodge and others: Discussion on The Maintenance of Small Electric Power Plants.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.—Dr. A. Ekstrom: The Applications of Electricity to Agriculture.
INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 7.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems, and the Problem of Standardisation.
CERAMIC SOCIETY (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—Annual Meeting.
RAILWAY CLUB (at 25 Tothill Street, S.W.1), at 7.30.—J. F. Garms: The Importance of Secondary Train Services.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Prof. P. Abercrombie: The Planning of East Kent.
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Prof. Gottlieb: Diseases of the Gingival Margin.
SUGAR BEET INDUSTRY IN GREAT BRITAIN.

TUESDAY, APRIL 12.

SOCIETY FOR THE STUDY OF INEBRIETY (at Medical Society of London), at 4.—Dr. R. W. Branthwaite and others: Discussion on The Inebriates Act of 1898.
ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—E. H. Cunningham-Craig: Jet and Jetonised Material.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—T. Clarkson: The Recovery and Utilisation of Heat from the Exhaust Gases of Internal Combustion Marine Engines.
LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—J. A. Simes: Butterfly Hunting in Central and Southern Europe (Bacot Memorial Meeting).
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. J. Bedford: Big Fleas and Little Fleas; or Notes from a Nature Photographer's Diary.
INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Burnley Section) (at Municipal College, Burnley), at 7.15.—Annual General Meeting.
INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 89 Elmbank Crescent, Glasgow), at 7.30.—J. G. Worker: Latest Developments in Underfed Stoker Practice in the United States.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. C. Freeman: The Production and Modern Applications of Dissolved Acetylene.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Prof. R. R. Gates: A Naturalist on the Amazon.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—S. Mavor: The Applications of Machinery at the Coal Face.

WEDNESDAY, APRIL 13.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. J. W. Heslop Harrison: Induced Mutations and their Importance for Evolution.

THURSDAY, APRIL 14.

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY, at 7.

PUBLIC LECTURE.

SUNDAY, APRIL 10.

GUILDHOUSE (Eccleston Square), at 3.30.—Rev. Father Andrew: Christianity

CONFERENCES.

APRIL 11 TO 13.

FRENCH ASSOCIATION DES ANATOMISTES (jointly with the Anatomical Society of Great Britain and Ireland) (at University College).

APRIL 20 TO 24.

JOURNÉES MÉDICALES MARSEILLAISES ET COLONIALES (at Marseilles).—Prof. Cantacuzène: The Role of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.



SATURDAY, APRIL 16, 1927.

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The Development of Natural History Museums.

AT the present time there are scores of natural history museums, national, municipal, and semi-private, scattered throughout the British Isles, all attempting to serve science by presenting to the people the crude material of scientific study and, less generally, the results of certain kinds of scientific research. Their condition causes uneasiness to the onlooker who realises how potent an instrument museums might be in instilling scientific knowledge and creating that staunch popular backing which is necessary to bring science to its own in the life of the nation.

The story of many, perhaps the majority, of provincial museums is the same. They begin in a burst of enthusiasm, the white heat wanes, the care of the collection falls upon a dwindling number of voluntary workers, there is no proper provision for upkeep, and the end is disrepair, mouldy collections, dust-laden shelves—the 'museum' of the comic papers. These museums need encouragement, help, and money. The Carnegie United Kingdom Trustees have decided upon a work of national importance in undertaking, with the help of Sir Henry Miers, an inquiry into the conditions of these "imperfectly organised and to a large extent unappreciated" institutions. The national museums and the museums of the larger municipalities stand in a different category. They are for the most part well tended and well cared for, their exhibited collections are kept up-to-date, in so far as up-to-dateness is satisfied by the replacement of poor specimens, the occasional filling in of blanks and a little more. But have even these museums realised the need of marching with the advance in knowledge?

The purpose of a great natural history museum is twofold, as Sir Ray Lankester has pointed out in a recent letter to NATURE (Feb. 26, p. 314). It is a storehouse for the safeguarding of objects of natural history which are of historic interest, and of the vast collections of specimens gathered from every quarter of the globe and from the world's seas. On these are founded to a large extent our knowledge of the basic natural history of geographical regions, and they afford the raw material for further researches, geographical, morphological, and phylogenetic. Much more importantly, so far as the living generation is concerned, they give the ordered facts on which alone can be based the war against disease, and the search for Nature's wealth, which together determine the economic fate of the

human race ; but this is an aspect which demands description by specialists. For all these ends the storing of such material, if it is to be at all valuable for reference, demands a minuteness of classification in proportion to the extent of the collections, and therefore a prime duty of a museum staff must be that of the systematic classifier.

The other great purpose of the large museum (and almost the sole purpose of the small museum) is exhibitory and educative, for the instruction not only of the unlearned but inquiring public, but also of all grades of receptive mind even to the professional expert, since there is no book-knowledge but may be bettered by reference to the facts themselves, and these could often be displayed from the great stores of museum properties. The growing recognition that an essential duty of museums supported by the public purse is educative, is shown in the placing of the newer State museums under the departments identified with public education, the Victoria and Albert Museum under the Board of Education, the Royal Scottish Museum under the Scottish Education Department. It is a kind of linkage that might well be extended to other public museums, provided the State department concerned is prepared to recognise and develop the enormous teaching potentiality of museums instead of permitting them to adhere as excrescences on the educational body.

Have the natural history museums in Britain played up to their educational function ? They have not. Take the Natural History Museum at South Kensington, not because it is worse than the others, but because its size emphasises the defects. Its galleries are for the great part filled with thousands of specimens arranged 'systematically.' The principle underlying systematic natural history is phylogeny, that is to say, systematic collections must be looked upon as illustrating natural relationships and ultimately the evolution of life upon the globe. Since no one can claim that these great collections with their multiplicity of genera and species *visibly demonstrate* throughout the series natural relationships or the lineage of animal life, their primary purpose fails, and they must be regarded mainly as groupings convenient for showing a conspectus of the animal world and for the identification of specimens.

How do the collections meet these needs ? It is impossible as a matter of quantity to exhibit every species ; it would be useless from a qualitative point of view to do so, for the discrimination of the modern expert seizes upon differences invisible even to the observant eye. But this impossibility

makes accurate identification from the exhibited collections a hazardous matter for the non-expert. The collections meet neither the phylogenetic nor the identification point of view. The indication is that their future development must be along the lines of drastic reduction, so that the series shall contain only readily distinguishable forms selected because of their historical, phylogenetic, or morphological interest, or because of a special attractiveness in themselves.

The implication of such a reduction is important. It means that, more and more, not only the specialist but also the general inquirer after detailed knowledge must be encouraged to supplement his observations in the galleries by appeal to the cabinet collections. This demands the presence of facilities not at present available in the museum, of easily accessible store collections, of well-lit, well-equipped, reasonably comfortable rooms available for the outside inquirer. Much more it implies such facilities for the museum staff which spends a lifetime organising and sorting the collections in gallery and in cabinet. Hitherto, in this technical aspect of reference collections containing specimens authoritatively named, the British Museum has been the central museum of the world. This position depends largely on the proportion of original specimens, 'type-specimens,' deposited by the naturalists who have named them ; and obviously, the museum which has already the widest collection is the museum in which a new type-specimen can be most usefully deposited. It is to examine these type-specimens that naturalists visit England from all over the world. The hidden cabinets form the 'British Museum' which is the premier natural history museum in the world ; it remains to be seen whether it can retain this position in face of the intelligent expenditure of America and Germany.

Sir Ray Lankester suggests that the exhibition space saved (and he contemplates reduction by one-half) might be used for the purpose of bringing up-to-date this hidden British Museum of research. With this view we disagree. There is a better purpose for the exhibition space, for the Natural History Museum has scarcely touched the fringe of real education, which must become part of the duty of a State museum. The greater American museums have spent much ingenuity and vast sums of money on the creation of realistic Nature groups, which transport the spectator into new realms. The main hall of the Natural History Museum at South Kensington, with its dark alcoves, is admirably adapted for such groups, and might well be given over to this purpose. But

while such groups are instructive, their main interest is spectacular, and the public demands more than a pageant: it thirsts for a deeper knowledge.

Nearly seventy years ago, Charles Darwin, an Englishman, with a new view-point revolutionised the thought of the world. What has the Natural History Museum of his own country done to make Darwin's world-moving discoveries current amongst his own people? What has it done to convert the 'fundamentalists,' of whom Great Britain as well as America has its share? Nothing! Except for a few isolated exhibits, shown almost in holes and corners as if with an apology lest they should intrude upon the systematic collections. Yet Darwin's mind was detailed and material: his theories are not as it were in the air: they rest upon accumulated facts and examples of a kind eminently suitable for exhibition in a museum. Some years ago the late Dr. Benjamin Peach in arranging the collections of Hugh Miller in the Royal Scottish Museum, Edinburgh, placed together a few of the actual specimens which had led the Cromarty stone-mason to certain of his conclusions. This practice might be extended. There is a vast body of general biological truths of vital importance in scientific thought, which could be illustrated, not by one or two examples, but by such a multiplicity of examples, culled from a wide range in the realms of zoology and botany, as would compel belief. Sir Ray Lankester thinks that such subjects—evolution, heredity, variation, natural selection, geographical distribution and variation, sex dimorphism, and hosts of others—should be the subject of museum lectures, and with this view we are in entire agreement; but how much more ought they to fill the galleries of a public museum for the constant reference and edification of the people?

Such collections to reach their highest efficiency must be planned and wrought out with a breadth of knowledge, and with a museum gift which is comparable to the creation of a striking and artistic poster; to them each specialist must make his contribution; they must be symposia rather than individual efforts. The hard-pressed specialists on the museum staff, overlaid with identification and classification and the sorting of new collections, cannot spare the time and consideration demanded by such biological exhibits. The ideal exhibitor is by nature a creative artist; the British Museum authority, to consult whom a zoologist comes from Japan or a tropical pathologist from Uganda, should be by nature a field-naturalist, must be by nature a methodist and a scholiast. The reorganisation of the exhibited collections on the

lines of the advancement of modern natural history demands the reorganisation of the staff.

On this, as well as on the grounds summarised by Sir Ray Lankester, an inquiry by Royal Commission into the "status, purposes, and organisation of the British Museum (Natural History) and other related institutions" is urgently needed. There are many aspects of museum activities, relationships, and influences which might be bettered by inquiry and definition: the aims of the museum itself: the overlapping and duplication of collections in London: the relation of the State museum as an educator, to the recognised educational and particularly the teaching institutes; its relation to other natural history museums supported by State funds, and to the public museums of Great Britain in general; and not least, when the Dominions, Crown Colonies and dependencies are equipping staffs of researchers into the Nature which surrounds them and the death which encompasses them, who risk their lives to fight disease and to bear the torch of scientific knowledge to the ends of the earth, let the Government of our Empire consider the imperial relationships of the British Museum.

Ethnology of Tuareg Tribes.

People of the Veil: being an Account of the Habits, Organisation and History of the Wandering Tuareg Tribes which inhabit the Mountains of Air or Asben in the Central Sahara. By Francis Rennell Rodd. Pp. xvi + 504 + 51 plates. (London: Macmillan and Co., Ltd., 1926.) 30s. net.

BY the "People of the Veil" are meant the Tuareg, whose country extends from the eastern edge of the central Sahara to the far edge of the western deserts of North Africa before the Atlantic zone begins, and from southern Algeria in the north to the Niger and the equatorial belt between the river and Lake Chad in the south. The name 'Tuareg' is not used by the people themselves; it is really a term of opprobrium originally applied to them by their enemies. They became known to the Arabs as the 'Veiled People,' because their men after reaching a certain age were, as they still are, in the habit of wearing a strip of thin cloth wound around their heads in such a manner as to form a hood over the eyes and a covering over the mouth and nostrils, only a narrow slit being left open for the eyes; and, in default of a national name, they themselves use the same locution in their own tongue to describe

the whole society of different castes which compose their community. They are usually included among the Berbers of North Africa: but Mr. Francis Rennell Rodd, the author of the latest book dealing with them, prefers to use the geographical term Libyans, and even doubts whether

a king, residing in the city of Agades, but he seems never to have enjoyed much authority, unless backed by the more important chiefs. His office is not hereditary, but he is elected by the representatives of certain tribes; and his tenure of office has always been very precarious. The reigning king is of slave descent, and the same has been the case with all his predecessors. The legal practice of slavery has of course been abolished in Air since the advent of the French in the beginning of the present century, but master and slave continue to regard each other by mutual consent in the light of their former relationship. Slavery among the Tuareg never involved great hardship; it was in slave-trading and not in slave-owning that they sinned against the ethical standards which are usually accepted in Europe. There are further the so-called *imghad*, or serfs, who are clearly the descendants of groups or individuals captured in war and afterwards released from bondage to form a caste enjoying a certain amount of freedom; they are in no sense considered to be the property of the noble tribe which originally possessed them, but the relationship is closer than that of suzerain and vassal. In the first stage the noble tribe represents the original pure Tuareg race, while the oldest *imghad* are the first extraneous people whom they conquered, "in some cases perhaps as early as in the Neolithic ages."

In addition to the social distinction between nobles and serfs, the Tuareg attach great importance to tribal classification. Among the inhabitants of the Air mountains a tribe is either of the category called the "People of the King" or of the Kel Owi, and this distinction means all that the difference between an ancient landed nobility and a parvenu commercial aristocracy denotes. Many of the older men of the "People of the King" say that there are no nobles among the Kel Owi at all.

In Air, as elsewhere among the Tuareg, a man's or woman's social status is determined by that of the mother; a woman, they say, carries her children before they are born, and so they belong to her and not to the father. If she marries a man of another tribe the children become members not of his but of her tribe; and Mr. Rodd states that "should inter-tribal hostilities break out they must leave their father and fight for their mother's tribe, even against their own parent if need so be." Similar statements have been made with reference to a few matrilineal peoples in other parts of the world, but they are quite exceptional and even of doubtful accuracy; hence it would have been



FIG. 1.—Tuareg camel-driver. From "People of the Veil."

the Tuareg are Berbers at all, like the other people so called in Algeria and Morocco. There are to-day four principal divisions of them. One of these groups consists of the people inhabiting Air, which is a mountainous oasis situated on a great caravan road from the Mediterranean to central Africa; and it is chiefly with this people and their country that Mr. Rodd's book deals in detail, as a result of a nine months' journey in the Tuareg country.

The people of Air have for several centuries had

well if the author had confirmed his assertion by actual cases in which Tuareg have been at war with their fathers on account of their method of tracing descent through the mother. He maintains that the frequency of monogamy is connected with the 'matriarchate.' But his statement relating to the Tuareg of Air, that in practice "monogamy is more frequent than polygamy," is true of all Muhammadan nations and of nearly all other peoples who allow polygamy, and nobody has ever been able to show that patrilineal peoples are more addicted to it than matrilineal ones; indeed, the prevalence of mother-right has, on the contrary, been partly traced to the practice of polygamy. Monogamy may certainly be a result of the regard in which women are held; but the supposition that their position in general is influenced by the system of reckoning kinship is not past all doubt.

Mr. Rodd observes that the Tuareg women are respected by their men in a manner which has no parallel in his experience, and that their unveiled countenances are in keeping with the perfect freedom they enjoy—though, wisely enough, he does not attribute the veil worn by the men to female supremacy. There can be little doubt that the veiling of women found in many parts of the Muhammadan world is not merely due to masculine jealousy but serves the object of protecting them from the evil eye, and in early Arabia very handsome men for the same reason veiled their faces, particularly at feasts and fairs; but though the belief in the evil eye is known to exist among the Tuareg, it does not seem to have anything to do with the veiling of their men. The author criticises some theories as to the origin of this peculiar custom, and is of opinion that up to the present no reasonable theory has been advanced. I think, however, that he has made a little too light of the suggestion that the veil was assumed by raiders who wanted to conceal their faces in order to escape recognition; he argues that the veil would

be of little use as a means of concealment. I have heard Moors who have come in contact with Tuareg express a very different opinion; and among the mountaineers of northern Morocco robbers blacken their faces so as not to be found out. The veil is not worn until some years have elapsed after the youth begins to carry a sword.

While Mr. Rodd gives us much minute and valuable information about the organisation, the social conditions, the mode of life, the trade and occupations, the architecture and art, and the history of the Tuareg of Air, he has much less to tell of their rites and beliefs. Only a few lines are

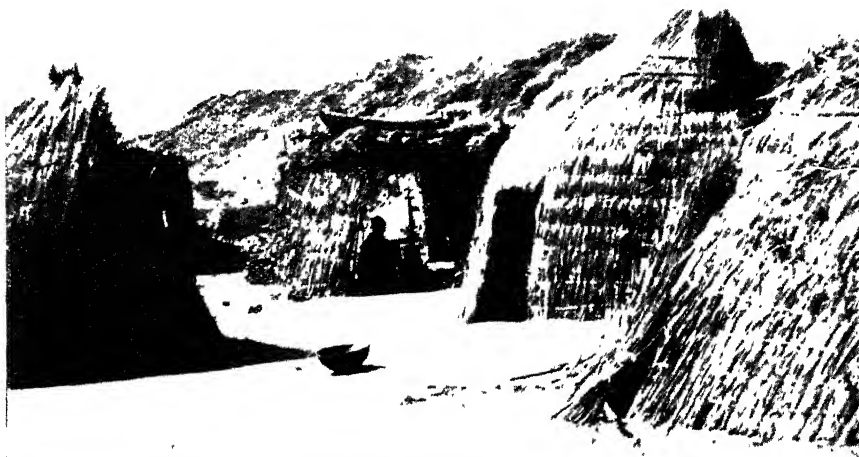


FIG. 2.—Tuareg huts at Auderas. From "People of the Veil."

devoted to their customs connected with childbirth, marriage, and death, which may not be so uninteresting as he assumes; and he modestly says that he was not sufficiently fluent in their language to learn much of their superstitions. "Such information," he rightly remarks, "can only be obtained after prolonged residence among a people." He believes that the frequent use of the cross in Tuareg ornamentation is due to early Christian influence. It may be so; but the cross is much older than Christianity, and cruciform devices occur among the tattoo-marks seen on Libyans represented on old Egyptian monuments.

It should be added that Mr. Rodd's book is an important contribution not only to our knowledge of the Tuareg, but also to the study of certain problems relating to the history and ethnology of the Sahara and North Africa in general. The illustrations are excellent. EDWARD WESTERMARCK.

Atomic Physics.

The Structure of the Atom. By Prof. E. N. da C. Andrade. Third edition, revised and enlarged. Pp. xviii + 750. (London: G. Bell and Sons, Ltd., 1927.) 30s. net.

PROF. ANDRADE'S well-known introduction to atomic physics has been very largely rewritten for this (the third) edition, and the size of the work has been approximately doubled. Some of the discussions of the earlier editions have been amplified, but in the main the increase in size represents the introduction of new subject matter. As before, the book is divided into two parts, of which the first is nominally devoted to the nucleus. A great deal of extranuclear matter is, however, disposed of in this section, in order to clear the ground for the later discussion of the outlying portions of the atom.

After a brief historical introduction, pride of place is appropriately given to an admirable account of the passage of swift electrified particles through matter—the problem which primarily led to the enthronement of the nuclear theory of the atom. Rutherford's α -particle scattering is naturally dealt with in some detail, together with an outline of the rather less definite evidence obtained from β -particle scattering. There is also a (much too brief) reference to the fundamentally important observations of Ramsauer and others on the behaviour of inert gases towards slow cathode rays—observations now extended, with refined methods, to the more 'aggressive' gases.

Part I. is also distinguished by an excellent account of the remarkable work conducted by Rutherford and his school during the last eight years, on the effects of extremely close collisions between swift α -particles and the nuclei of light atoms—the 'artificial' disintegration of matter and the estimation of the 'size' of the nucleus. Other topics which are concisely but adequately presented are: positive rays (including Aston's work on isotopes), the evidence for 'energy levels' within the nucleus, the interpretation of β - and γ -ray spectra and the deduction therefrom of details of the process of radioactive disintegration. Separate chapters are devoted respectively to more speculative hypotheses on the structure of the nucleus, and to an excellent account of 'classical' X-ray work—including Moseley's establishment of the importance of the concept of atomic number, Barkla's application of the scattering formula to the determination of the number of extranuclear electrons, and W. L. Bragg's work on the average

time-spatial distribution of these electrons. The necessary 'Digression' on optical spectra, which has been modified and enlarged, brings Part I. to a close.

Part II., which now occupies about three-fourths of the whole book, deals exclusively with the behaviour of the extranuclear electrons, and almost exclusively with the quantum explanations of this behaviour. A great deal of space is therefore allotted to the discussion of spectral series. This part of the discussion, which has been profoundly modified in the new edition, begins, inevitably, with the classical Bohr theory of the spectra of hydrogen and of ionised helium. This is followed by simplified expositions of Ehrenfest's adiabatic principle and Bohr's correspondence principle. The argument is then carried on to the case of 'hydrogen-like' atoms, in which two quantum conditions are required for the specification of the orbits, and to the problems of 'relativistic' fine structure, normal Zeeman- and first-order Stark effects. Examples are given of Sommerfeld's classical applications of the 'Sommerfeld-Wilson' quantising rules and of Bohr's use of the method of perturbations. After a preliminary attack on the spectrum of the general atom, with the evocation of selection rules and adoption of a third and fourth quantum number, the discussion of the spectroscopic evidence culminates in a remarkable chapter on multiplet theory and anomalous Zeeman effect. This chapter (xv.), which has been partially revised by Mr. R. H. Fowler, summarises some of the most eminent successes, and at the same time emphasises some of the most significant difficulties and inadequacies of the older quantum theory of line spectra.

Among other new chapters which enhance the value of the book, special reference must be made to an excellent summary of work on critical potentials. There is a particularly welcome account of Saha's theory—which is not always, even in astrophysical text-books, given the place it merits—and the extensions of Fowler and Milne. Klein and Rosseland's superelastic collisions, and resonance radiation (including quenching and 'sensitised fluorescence'), are briefly discussed.

The account of the evidence from X-ray spectra has been very considerably expanded, and now occupies a separate chapter. This chapter gives a useful account of measurements in 'soft' X-ray regions and of the transition from optical to X-ray spectra, and a brief discussion of the interesting dilemma of the 'relativity' doublets raised by the recent 'hot spark' work of Millikan and others.

The relation of the dynamical atom-model to

the periodic system of the elements is much more fully discussed than in the earlier editions. An account is given of the Stoner–Main Smith modification of Bohr’s original scheme, and McLennan’s new table of basic spectral terms is added in an appendix (v.).

The chief addition to the chapter on magnetism is the extended account of the beautiful experiments of Gerlach and Stern, which is supplemented by a particularly fine reproduction of some of the original photographs. There is, however, no discussion of Glaser’s work on diamagnetic gases at low pressures.

The relative positions of wave theory and classical quantum theory are summarised in a new chapter, which deals with dispersion, the Bohr–Kramers–Slater discussion of radiation fields, and the Compton effect.

The book closes with a brief but suggestive statement of the present position, and an account of the salient features of the newer quantum theory—or what seems doomed to be known for the present as the ‘Born–Jordan–Heisenberg–Pauli–Dirac–Schrödinger . . .’ mechanics.

The above—necessarily imperfect—analysis of the subject matter is intended to indicate the scope of the work, which is in many respects complementary to that of Sommerfeld’s well-known treatise. It should be obvious that the book is primarily addressed to the traditional ‘serious student’ of physics. The treatment is, however, so ordered that much of the text is accessible to readers who have a general rather than a professional interest in modern speculations on the structure of matter.

The general plan has been to give a lucid account of the essential features of each problem, and to supplement this by a judicious selection of references to original sources. Space is economised here and there by omitting details for which English readers would naturally turn to such standard treatises as those of the Braggs, Aston, or Siegbahn. The result of this plan has been the production of a book which is specially adapted to serve as a general guide for senior students of physics and for those who are preparing to embark upon independent work. There are also, unfortunately, many older experimenters whose employment leaves them little time to keep in touch with new work which does not bear obviously and directly upon the subjects of their own special studies: to these, too, Andrade’s book will make a special appeal.

The appeal in many cases will be none the

weaker because the treatment is throughout physical rather than mathematical; and although the greater part of the book is necessarily allocated to the theoretical superstructure, unusual attention and respect are paid to the experimental methods and observational data at the foundations. The information has not always been brought completely up-to-date—it is many months since X-ray spectroscopy stopped short at such puny wave-lengths as 14 A.U., and it is no longer held to be established that the absorption edges of an element depend upon the allotropic form, though it has been shown that the effect of valency can be exhibited even in the X-ray emission spectra of compounds—but oversights of this nature are inevitable in so comprehensive a survey. Certain omissions—as that of any discussion of band spectra—were also inevitable, as is pointed out in the author’s preface; perhaps one of the most regrettable is the absence of any detailed discussion of the outstanding problem of X-ray absorption. As the problem by its nature is rebellious to direct treatment by the correspondence principle, which is the key to so great a part of the book, this omission is not unnatural.

Even if, as the author forecasts, much of the book will need to be rewritten in terms of the new mechanics and the spinning electron, the work in its present form stands as a very valuable exposition of the existing state of our knowledge of atomic structure, and one which is not likely to be superseded in the near future. The advances made even as the book was passing through the press are sufficient to demonstrate the futility of any immediate attempt to assemble, in a work of this kind, more than the barest outlines of the new methods of attack. It is to be hoped, however, that in the next edition it will be possible to include an account of the newer physics which, as yet, is but dimly to be discerned, stirring lightly in the matrices of the new dynamics.

The book is well produced, and the new plates are worthy companions to the beautiful reproductions in the earlier editions. The price has been increased—one serious defect in a book which is in all other respects so well adapted to the needs of the experimental physicist—but no one appreciating the amount of new work incorporated in this edition, or familiar with the cost of production of scientific books, will maintain that the increase is unwarranted. There is an excellent index, of the type (combined author and subject) which ought to be made compulsory in all books on physics.

H. R.

Cell Division.

Das Problem der Zellteilung physiologisch betrachtet.

Von Prof. Alexander Gurwitsch. (Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere, Band 11.) Pp. vii + 221. (Berlin: Julius Springer, 1926.) 16.50 gold marks.

IN this monograph the professor of histology at the University of Moscow puts together the results of a series of researches, carried out in his laboratory, which are so novel in outlook and method of experimental approach that some time must elapse before biologists in general can be prepared to express an opinion upon them. In introductory chapters the problem of cell division is approached in a somewhat artificial semi-philosophical manner, leading up to the general conclusion that the process of cell division is very largely determined as the result of influences received at the surface of the cell.

As possible influences leading to cell division upon reception at the cell surface two are considered: (1) Haberlandt's necro-hormone, a generalised suggestion arising out of experiments which led Haberlandt to think that the meristem divisions giving rise to wound cork were initiated in part as the result of substance diffusing from the wounded cells; (2) the 'mitogenetic' radiations, upon which much work has been done in Gurwitsch's laboratory. The regular cell divisions in the apical meristem of the onion root suggest an influence, inducing cell division, centred within, and radiating from, the apical meristem itself.

Gurwitsch then proceeds to test the influence of this 'mitogenetic' radiation, emanating from the root apex, in inducing cell division in the still meristematic region of another root, when the apex of the first root is pointed, at close range, toward the flank of the second root. Normally, in the region behind the apex, when a root is examined, the number of cells found in division on either side of a median line through a longitudinal section is approximately the same. But when, on one side of this median line, the cells have been exposed to this 'mitogenetic' influence of another root apex, many more cells are found in stages of division on this side of the root.

In the main, this general line of experimental evidence is the chief evidence brought forward in support of this very new idea of a mitogenetic radiation. Modifications of the experiment lead to the conclusions that the rays are reflected from a plane glass surface, penetrate quartz, and are

probably ultra-violet rays of wave-length between 1900 Å.U. and 2000 Å.U.

A few experiments with root extracts are given as evidence that these rays are released as the result of the interaction of a substance, 'mitotin,' with an enzyme 'mitotase,' on analogy with the phosphorescence of 'luciferin' under enzyme action. The experimental basis given for this conclusion is not, however, very complete. These views of Gurwitsch are given general application to the phenomena of cell division in both animal and plant; it remains to be seen how they will stand the test of time.

Our Bookshelf.

From Tribe to Empire: Social Organisation among Primitives and in the Ancient East. By Prof. A. Moret and G. Davy. Translated by V. Gordon Childe. (The History of Civilisation Series.) Pp. xxx + 371. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1926.) 16s. net.

IN his foreword, Mr. Henri Berr emphasises the importance of the social factor in history, and points out that in the early volumes of this series, which deals with the evolution of humanity, it has been necessary repeatedly to refer to the problem to which it gives rise. This volume thus marks a critical point in the general scheme of the series. For here we 'come to grips' with the problem. The aim of the book is to introduce the social as such into historical explanation. We find, therefore, that it falls into two parts. In the first part, six chapters introduce the reader to what is known of primitive social development, the material being arranged in a progressive framework. After a statement of the problem, it starts with the totemic organisation in which the individual is lost in the totemic group, or, perhaps it might almost be put, the individual is a function of the totem. It then traces the gradual development of individualised power. This is in effect the centralisation of the magic of the totem, of the land and the community, in one individual, the king. In Part 2 the transition of the clan to the kingdom is considered. This is traced in the early civilisation of Egypt and Mesopotamia. Finally, the working out of the social factor is studied in the first empires of the Orient, and the reader is carried down to the Egypto-Hittite *entente* and the invasion of Egypt by the peoples of the sea in the Nineteenth Dynasty.

The application of primitive sociological data to the elucidation of archaeological and historical problems is of course not new, but here it is conceived on a grand scale, and worked out in detail with much ingenuity. A word of caution may not be out of place. In this field much is uncertain, at any rate of early days. It is impossible, for example, to say how great was the

extent of the subordination of the individual to the whole. The large generalisations based upon the application of the prevalent analysis to what is often the merest outline, give rise to an uneasy feeling that the interpretation of the more obscure facts has had to square with theory rather than that it has evolved naturally from the facts themselves. In other words, the argument from analogy may have been unduly strained in its application to the internal conditions of Egypt and Mesopotamia.

The Indian Zoological Memoirs on Indian Animal Types. 1: Pheretima (The Common Indian Earthworm). By Prof. Karm Narayan Bahl. Pp. iv + 72. (Lucknow: The Methodist Publishing House, 1926.) 1.8 rupees.

A COMMITTEE of zoologists in India has arranged for the preparation of a series of memoirs on the lines of the well-known memoirs published by the Liverpool Marine Biological Committee. Hitherto students of zoology in India, while dissecting Indian types of the various phyla, have had chiefly to use descriptions based on British representatives of those phyla. The present is the first of the series of memoirs on Indian animal types; others are contemplated on a leech, a starfish, a centipede, a scorpion, an ascidian, a dogfish, a catfish, and a lizard.

Prof. Bahl's account of the common Indian earthworm *Pheretima posthuma* sets a worthy standard for the series. The chapters deal successively with the habits and habitat, external features, body wall, coelom, the alimentary canal, the vascular, excretory, nervous, and reproductive systems, and the development. A concluding chapter contains concise directions for practical work. As would be expected from the author's published papers, the accounts of the vascular and excretory systems are particularly full and well done; perhaps a little less detail in parts of the vascular system would have sufficed. In addition to the examination of the worm by dissection, due attention is devoted to the microscopic study of excised organs and tissues and of transverse sections. The volume is adequately illustrated by two half-tone plates and 29 line drawings in the text.

The author is to be congratulated upon his suggestion that memoirs on common Indian animals should be prepared, and upon his own excellent contribution to the series.

A Book of South African Flowers. By D. Barclay, H. M. L. Bolus and E. J. Steer. Pp. xviii + 174 (57 plates). (Capetown and Johannesburg: The Specialty Press of South Africa, Ltd.; London: L. Reeve and Co., Ltd., 1925.) 21s.

SINCE its discovery, visitors have been struck by the remarkable flora of Cape Colony, and especially of the particular region known to botanists as the "South-western Region." Here the landscape is often dominated by such unique types of plants as *Protea*, *Leucadendron*, *Strelitzia*, etc., which are found nowhere else in the world. In order

to spread a wider knowledge of these interesting and beautiful plants "among those for whom the purely scientific botanical books have little or no meaning," the Wild Flower Protection Society has published a book with illustrations, accompanied by interesting biological notes suitable for the ordinary reader. Most of the plants described are those which were in danger of becoming extinct from various causes, mainly, however, the Capetown flower-seller, and are now protected by law from being destroyed. Thirty-two of these are illustrated by coloured plates, some of them good, some rather poor, and the remainder by photographs. The text has been written by Mrs. Bolus, the Curator of the Bolus Herbarium, Kirstenbosch, the drawings are by Miss Barclay, and the photographs by Mr. Steer. We feel sure not only that the authors' modest hope "that the book may prove useful in schools" will be fulfilled, but also that it will be just the thing for those interested in the Cape flora generally, and especially for the visitor with limited time who wishes to know something about the wild plants around him.

Practical Microscopy: an Introduction to Microscopical Methods. By Dr. F. Shillington Scales. Third edition. Pp. ix + 332. (London: Baillière, Tindall, and Cox, 1926.) 8s. 6d. net.

IN this third edition the author (whom death has recently claimed) has revised the text and introduced much new matter, particularly in the chapters dealing with the design of the microscope, choice of an instrument, objectives and accessories, and many of the newest models and pieces of apparatus are illustrated. The chapter on the practical optics of the microscope is exceedingly good, and gives all the essentials of the subject in simple form. A chapter on photo-micrography is included. The section on microscopical technique gives an excellent summary of the essentials of the subject—fixing, hardening, section cutting, staining and mounting—and the budding microscopist will find that it will carry him a long way in his work. Tables, formulæ, and a useful bibliography are included in an appendix. R. T. H.

The Goodness of Gods. By Prof. Edward Westermarck. (The Forum Series.) Pp. vi + 58. (London: Watts and Co., 1926.) 1s. net.

DR. WESTERMARCK'S contribution to the "Forum Series" consists of four chapters in which he follows up the development of the idea of god from its earliest beginnings among primitive peoples in the belief in supernatural beings, to its fully developed form in the higher religions, the religion of the ancient Egyptians, Zoroastrianism, the Vedic religion, Christianity, and Mohammedanism. In the final chapter, "The Betterment of the Gods," the author deals specifically with the ethical side of his theory. The treatment in so small a compass is necessarily concise, and the reader is referred for the data upon which Dr. Westermarck's views are based to his "Origin and Development of the Moral Idea."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Scattering of Electrons by a Single Crystal of Nickel.

IN a series of experiments now in progress, we are directing a narrow beam of electrons normally against a target cut from a single crystal of nickel, and are measuring the intensity of scattering (number of electrons per unit solid angle with speeds near that of the bombarding electrons) in various directions in front of the target. The experimental arrangement is such that the intensity of scattering can be measured

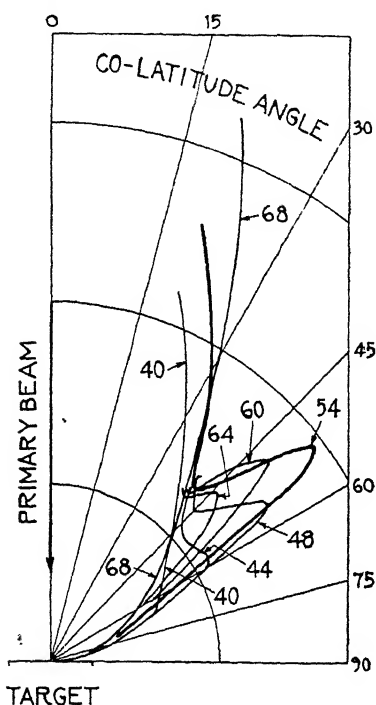


FIG. 1.—Intensity of electron scattering vs. co-latitude angle for various bombarding voltages—azimuth-{111}-330°.

in any latitude from the equator (plane of the target) to within 20° of the pole (incident beam) and in any azimuth.

The face of the target is cut parallel to a set of {111}-planes of the crystal lattice, and etching by vaporisation has been employed to develop its surface into {111}-facets. The bombardment covers an area of about 2 mm.² and is normal to these facets.

As viewed along the incident beam the arrangement of atoms in the crystal exhibits a threefold symmetry. Three {100}-normals equally spaced in azimuth emerge from the crystal in latitude 35°, and, midway in azimuth between these, three {111}-normals emerge in latitude 20°. It will be convenient to refer to the azimuth of any one of the {100}-normals as a {100}-azimuth, and to that of any one of the {111}-normals as a {111}-azimuth. A third set of azimuths must also be specified; this bisects the dihedral angle between adjacent {100}- and {111}-azimuths and includes a {110}-normal lying in the plane of the

target. There are six such azimuths, and any one of these will be referred to as a {110}-azimuth. It follows from considerations of symmetry that if the intensity of scattering exhibits a dependence upon azimuth as we pass from a {100}-azimuth to the next adjacent {111}-azimuth (60°), the same dependence must be exhibited in the reverse order as we continue on through 60° to the next following {100}-azimuth. Dependence on azimuth must be an even function of period $2\pi/3$.

In general, if bombarding potential and azimuth are fixed and exploration is made in latitude, nothing very striking is observed. The intensity of scattering increases continuously and regularly from zero in the plane of the target to a highest value in co-latitude 20°, the limit of observations. If bombarding potential and co-latitude are fixed and exploration is made in azimuth, a variation in the intensity of scattering of the type to be expected is always observed, but in general this variation is slight, amounting in some cases to not more than a few per cent. of the average intensity. This is the nature of the scattering for bombarding potentials in the range from 15 volts to near 40 volts.

At 40 volts a slight hump appears near 60° in the co-latitude curve for azimuth-{111}. This hump develops rapidly with increasing voltage into a strong spur, at the same time moving slowly upward toward the incident beam. It attains a maximum intensity in co-latitude 50° for a bombarding potential of 54 volts, then decreases in intensity, and disappears in co-latitude 45° at about 66 volts. The growth and decay of this spur are traced in Fig. 1.

A section in azimuth through this spur at its maximum (Fig. 2—Azimuth-330°) shows that it is sharp in azimuth as well as in latitude, and that it forms one of a set of three such spurs, as was to be expected. The width of these spurs both in latitude and in azimuth is almost completely accounted for by the low resolving power of the measuring device. The spurs are due to beams of scattered electrons which are nearly if not quite as well defined as the primary beam. The minor peaks occurring in the {100}-azimuth are sections of a similar set of spurs that attains its maximum development in co-latitude 44° for a bombarding potential of 65 volts.

Thirteen sets of beams similar to the one just described have been discovered in an exploration in the principal azimuths covering a voltage range from 15 volts to 200 volts. The data for these are set down on the left in Table I. (columns 1-4). Small corrections have been applied to the observed co-latitude angles to allow for the variation with angle of the 'background scattering,' and for a small angular displacement of the normal to the facets from the incident beam.

If the incident electron beam were replaced by a beam of monochromatic X-rays of adjustable wavelength, very similar phenomena would, of course, be observed. At particular values of wave-length, sets of three or of six diffraction beams would emerge from the incident side of the target. On the right in Table I. (columns 5, 6 and 7) are set down data for the ten sets of X-ray beams of longest wave-length which would occur within the angular range of our observations. Each of these first ten occurs in one of our three principal azimuths.

Several points of correlation will be noted between the two sets of data. Two points of difference will also be noted; the co-latitude angles of the electron beams are not those of the X-ray beams, and the three electron beams listed at the end of the Table appear to have no X-ray analogues.

The first of these differences is systematic and may

be summarised quantitatively in a simple manner. If the crystal were contracted in the direction of the incident beam by a factor 0.7, the X-ray beams would be shifted to the smaller co-latitude angles θ' (column 8), and would then agree in position fairly well with the observed electron beams—the average difference being 1.7°. Associated in this way there is a set of electron beams for each of the first ten sets of X-ray beams occurring in the range of observations, the electron beams for 110 volts alone being unaccounted for.

These results are highly suggestive, of course, of the ideas underlying the theory of wave mechanics, and we naturally inquire if the wave-length of the X-ray beam which we thus associate with a beam of electrons is in fact the h/mv of L. de Broglie. The comparison may be made, as it happens, without assuming a particular correspondence between X-ray and electron beams, and without use of the contraction factor. Quite independently of this factor, the wave-lengths of all possible X-ray beams satisfy the optical grating formula $n\lambda = d \sin \theta$, where d is the distance between lines or rows of atoms in the surface of the crystal—these lines being normal to the azimuth plane of the beam considered. For azimuths {111} and {100}, $d = 2.15 \times 10^{-8}$ cm. and for azimuths {110}, $d = 1.24 \times 10^{-8}$ cm. We apply this formula to

In considering the computed values of $n(\lambda mv/h)$, listed in the last column, we should perhaps disregard those for the 110-volt beams at the bottom of the

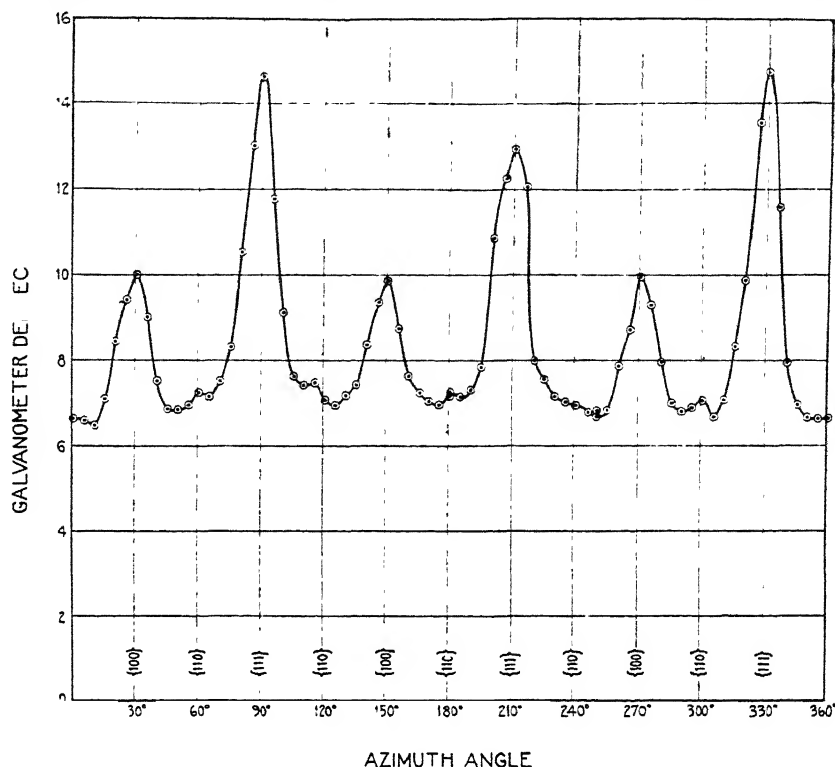


Fig. 2.—Intensity of electron scattering vs. azimuth angle—54 volts, co-latitude 50°.

Table, as we have had reason already to regard these beams as in some way anomalous. The values for the other beams do, indeed, show a strong bias toward

TABLE I.

Azimuth.	Electron Beams.			X-ray Beams.						
	Bomb. Pot (volts).	Co-lat. θ .	Intensity.	Reflections.	$\lambda \times 10^8$ cm.	Co-lat. θ .	Co-lat. θ' .	$v \times 10^{-8}$ cm/sec.	$n\lambda \times 10^8$ cm.	$n \left(\frac{\lambda mv}{h} \right)$.
{111}	54	50°	0.5	{220}	2.03	70.5	52.7	4.36	1.65	0.99
	100	31	0.5	{331}	1.49	44.0	31.6	5.94	1.11	0.91
	174	21	0.9	{442}	1.13	31.6	22.4	7.84	0.77	0.83
	174	55	0.15	{440}	1.01	70.5	52.7	7.84	1.76	2(0.95)
{100}	65	44	0.5	{311}	1.84	59.0	43.2	4.79	1.49	0.98
	126	29	1.0	{422}	1.35	38.9	27.8	6.67	1.04	0.95
	190	20	1.0	{533}	1.04	28.8	20.4	8.19	0.74	0.83
	159	61	0.4	{511}	1.05	77.9	59.0	7.49	1.88	2(0.97)
{110}	138	59	0.07	{420}	1.22	78.5	59.5	6.98	1.06	1.02
	170	46	0.07	{531}	1.04	57.1	41.7	7.75	0.89	0.95
{111}	110	58	0.15	..	..	..	..	6.23	1.82	1.56
{100}	110	58	0.15	..	..	..	..	6.23	1.82	1.56
{110}	110	58	0.25	..	..	..	..	6.23	1.05	0.90

the electron beams without regard to the conditions which determine their distribution in co-latitude angle. The correlation obtained by this procedure between wave-length and electron speed v is set down in the last three columns of Table I.

small integers, quite in agreement with the type of phenomenon suggested by the theory of wave mechanics. These integers, one and two, occur just as predicted upon the basis of the correlation between electron beams and X-ray beams obtained by use of

the contraction factor. The systematic character of the departures from integers may be significant. We believe, however, that this results from imperfect alignment of the incident beam, or from other structural deficiencies in the apparatus. The greatest departures are for beams lying near the limit of our co-latitude range. The data for these are the least trustworthy.

C. DAVISSON.
L. H. GERMER.

Bell Telephone Laboratories, Inc.,
New York, N.Y.,
Mar. 3.

The Brain of Laplace.

THE bicentenary of the death of Newton (March 20, 1727) is within a fortnight of the centenary of the death of Laplace (March 5, 1827), and no one acquainted with the work of both can think of one or other except in association. It may, therefore, not be an unfitting occasion to refer to an historical point with regard to the great Frenchman, when we are celebrating the great Englishman.

The physiologist and anatomist Magendie propounded the theory that the intelligence of a human being was in the inverse ratio of the amount of cerebro-spinal fluid contained in the brain case. Writing in 1827, the year of Laplace's death, his "*Mémoire physiologique sur le cerveau*,"¹ he inserted the following words:

"Je me suis trouvé dans la douloureuse nécessité d'examiner le cerveau d'un homme de génie mort dans un âge avancé, mais jouissant encore de la plénitude de ses facultés intellectuelles; la somme totale du liquide céphalo-spinal ne s'élevait pas à deux onces, et les cavités du cerveau en contenaient à peine un gros" [$=\frac{1}{8}$ once].

I have been unable so far to find any further reference in the writings of Magendie "to the brain of this man of genius who died at an advanced age" and in the fullness of his intellectual powers. Magendie appears to have given no further account of this brain; at least I have found none. Laplace died at the age of seventy-eight in the year Magendie wrote. I have also failed to discover any minute record of Laplace's death which would suggest that an autopsy was made or was a "douloureuse nécessité." I would venture, therefore, to ask those who may be better acquainted than I am with the circumstances of Laplace's death to let me know why his brain came into Magendie's possession and whether a full report on it was ever written. Magendie, indeed, mentions no name, and this might lead one to consider his investigation of the matter was confidential. However, I think the ascription is certain, for quite recently Miss Helen Hunter Baillie—a lady who combines the blood of other famous anatomists with that of a famous author,² placed in the hands of Miss Miriam Tildesley a letter of Joanna Baillie to her great niece Miss Sophy Milligan. This letter, dated Hampstead, Monday, 1834, contains the following important paragraph:

"MY DEAR SOPHY. . . . Dr. Somerville told us not long ago a whimsical circumstance regarding the head of La Place, the famous French astronomer. Some Ladies and Gentlemen went one day to the house of Majendie (sic!), the great anatomist, to see the brains of this Philosopher which they conjectured must be of a very ample size, and seeing a preparation on the table answering

their expectation they were quite delighted. 'Ah! see what a superb brain, what organs, what developments! This accounts completely for all the astonishing power of his intellect, etc.' Majendie, who was behind them and overheard all this, stepped quietly forward and said: 'Yes, that is indeed a large brain, but it belonged to a poor Idiot, who when alive scarcely knew his right hand from his left. This, Ladies and Gentlemen' (handing to them a preparation of a remarkably small brain), 'this is the brain of La Place.' Dr. Somerville was told this anecdote by Majendie himself. . . .

Your affectionate Aunt, J. BAILLIE."

This Dr. Somerville can scarcely be other than the physician, fellow of the Royal Society, and husband of Mary Somerville, the learned lady who studied Newton's "*Principia*" in the original, was the correspondent of Laplace, and paraphrased his "*Mécanique Celeste*." There can thus be no doubt that Magendie was in possession of the brain of Laplace, and very little doubt that the passage in the "*Mémoire physiologique sur le cerveau*," written 1827, refers to that brain. The questions I would put to the French readers of NATURE are these: What became of Magendie's preparations? Have they, and with them Laplace's brain, survived until to-day? If so; has any one reported on it, or does any account by Magendie other than that I have cited, written or printed, exist? So few brains of great thinkers have been available for examination, that it would be a real disaster if Laplace's should have had only four lines devoted to it.

KARL PEARSON.

Galton Laboratory,
University College, London,
Mar. 31.

The Microscopical Examination of Flint Surfaces.

DURING the course of my work in the experimental fracture of flint by (a) human blows delivered by a hammer-stone, (b) unguided percussion, (c) unguided pressure, and (d) the application of heat, it became, in my opinion, possible, by a close examination of an extensive series of each of the differing types of flaking produced by these various methods of fracture, to differentiate between the work of man, and that of Nature ("*Pre-Palæolithic Man*," W. E. Harrison, publisher, Ipswich). While engaged upon this research I was much interested to notice that not only the type of flaking of the different series served to distinguish them from each other, but also that this difference appeared to find support, though in a less obtrusive manner, in the appearance of the surface of the flints broken by the methods above enumerated.

Most of those who are familiar with fractured flints of prehistoric date will have probably noticed the marked differences, often observable to the naked eye, between, for example, specimens broken by thermal effects and others fractured by human blows. The surfaces of the flake-scars of the former exhibit, generally, a much duller, less bright, surface than those of the latter. It occurred to me that this difference was caused possibly by the fact that these surfaces differed in texture, and had thus offered a differing resistance to the natural force, or forces, responsible for the imposition of 'polish,' or 'gloss,' upon the flake-scars of fractured flints. Further, it seemed highly probable that this difference in texture, if it existed, would have been most likely to have been produced by the two differing forms of fracture, and I compared, provisionally, the surfaces of a flint broken by thermal effects, to those of an apple which has been pulled in half with the hands and exhibits a rough surface, while I likened the surfaces of the

¹ Published by Magendie in his own *Journal de Physiologie expérimentale et pathologique*, Tome 8, p. 228; 1828.

² The mother of Joanna Baillie was sister of William and John Hunter.

flake-scars of the flint broken by human blows to the smooth surface of an apple cut in half by a knife.

In order to make some test of this theory, I procured examples of good, sound flint from the detritus-bed at the base of the Red Crag of Suffolk, and having fractured some by means of a hammer-stone,



FIG. 1.—Photo-micrograph of surface of flint fractured by human blows. ($\times 100$)

and others by putting them into a fire, thus producing flake-scars by (a) human blows and (b) thermal effects, I had photo-micrographs taken of the two surfaces in order to see if they differed in appearance. A number of specimens were examined and photographed, and the surfaces here illustrated (Figs. 1 and 2) may, I think, be said with fairness to be typical. Fig. 1 shows the type of surface produced by human blows, while Fig. 2 illustrates the type of

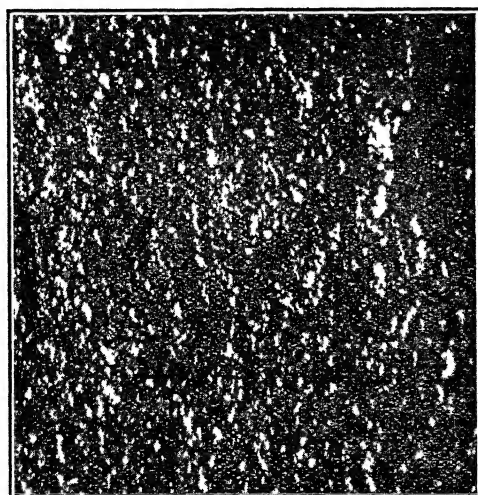


FIG. 2.—Photo-micrograph of surface of flint fractured by thermal agency. ($\times 100$.)

surface produced by thermal fracturing. An examination of these illustrations will show that the two surfaces differ from each other, and that this difference takes the form of the greater or lesser number, and prominence, of the white markings visible on the photographs.

Though it is possible that these markings point to

the 'thermal' surface being rougher than that produced by human blows, yet this is by no means certain. In fact, I am unable at present to say what these markings actually represent. But I believe that, though illustrating such a small area of the flint under examination, the photographs are representative of the two types of surface mentioned, and that the differences here indicated, plus the well-known other divergences between the flake-scars formed by human blows and thermal effects, now make it possible to differentiate, with confidence, between them.

I conceive that differences, though less easily observable, may exist between the surfaces of flints fractured by human blows and natural pressure, but so far I have not been able to establish this very important fact to my satisfaction. I believe, however, that this method of attempting to ascertain the manner in which a flint has been broken, though novel, has great possibilities before it, and will lead to very definite and valuable scientific results.

J. REID MOIR.

One House, Ipswich.

Haze.

With regard to the composition of the haze which often obstructs visibility in the summer, the following experiments may be of interest owing to the curious results and the make-shift methods which had to be used.

In August last, while staying on the coast of Norfolk, a well-marked haze appeared covering the whole country on Aug. 31 and Sept. 1. This had the characteristic bluish look often seen in summer haze. There was at the same time a strong wind blowing from the sea from north-west by north, which on Sept. 1 veered to nearly due north, the velocity being nearly 20 m.p.h. as measured by the flight of thistledown over a measured distance. The sea was rough, and the haze was such that the limit of visibility was about 5 miles.

Having no instruments with me with which to obtain samples of this haze, an instrument was improvised as shown on the sketch (Fig. 1). An empty peach tin 100 mm. diameter had a hole about 2 mm. diameter made in the centre of the bottom. The tin, A, was lashed to a piece of board with string, the bottom being brought up against a step, B, cut on the edge of the board; a microscope slide, C, was fixed opposite the hole in the bottom of the tin by means of a wedge, W, between it and the tin. This wedge also served the purpose of adjusting the distance between the slide and the hole to about 2 mm. The board carrying the tin was attached to a stake about 4 ft. 6 in. high, which was fixed in the ground with the mouth of the tin facing the wind.

A clean slide having been placed in position behind the tin, a definite patch became visible in 45 minutes on the glass opposite the hole, where the jet of air produced by the hole struck the slide. It was left in position for a little more than an hour, when the slide was removed and another put in its place which also received a patch visible to the naked eye. These patches, on examination under the microscope, were found to consist of a mixture of drops of liquid and crystals. The first consisted almost entirely of drops when examined, the relative humidity at the time being 82 per cent.

On warming gently all the drops dried, leaving crystals mostly of a skeletal form with branches at 90°, but some were cubical, while a few were thin rhomboidal plates, and these latter did not deliquesce as the others did when the slide cooled. The second

slide was similar, except that there were in the drops larger numbers of rhomboidal crystals which showed no tendency to deliquesce, while on warming the slide numbers of cubical crystals appeared, with sides up to 24μ , clearly of common salt; also a number of

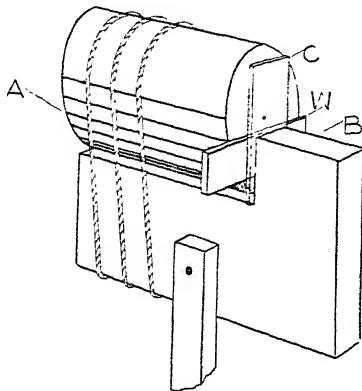


FIG. 1.

skeletal crystals with 90° arms (Fig. 2). It would appear, therefore, that this haze consisted almost entirely of crystalline salts, existing partly in the solid and partly in the deliquescent condition, and presumably mainly derived from sea spray, with

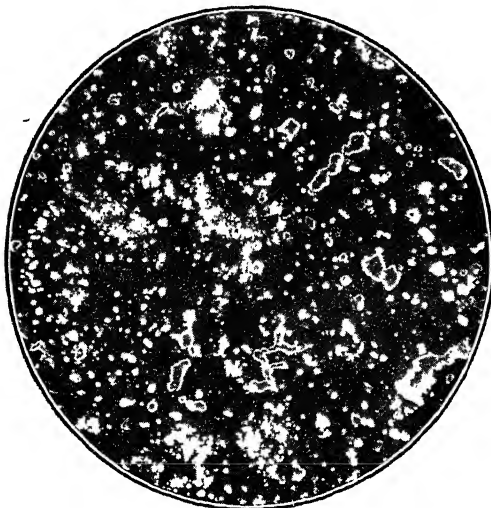


FIG. 2.

crystals, probably sulphates, derived from the smoke of cities on the north-east coast. With such a dense supply of hygroscopic crystalline matter in the air it would seem certain that a liquid fog would result from the deliquescence of the crystals present long before saturation, indeed probably in the neighbourhood of 70 per cent. relative humidity. J. S. OWENS.

47 Victoria Street,
Westminster, S.W.1.

Hereditary Choice of Food Plants in the Lepidoptera and its Evolutionary Significance.

MR. EDWARD MEYRICK, in his comments (NATURE, Mar. 12) upon my paper (*Proc. Roy. Soc.*, B, vol. 101, pp. 115-127) on the egg-laying instincts of *Pontania salicis*, so completely misses the point that it is difficult to deal with them seriously. The "new principle" to which he refers does not depend in the

slightest upon the work he mentions, but is deduced from work described in an earlier paper (*Proc. Roy. Soc.*, B, vol. 99). It may be summed up in two sentences: (1) Chemical agencies acting through ingested food have been shown to act directly on the germ plasm so as to affect its potentialities; (2) Therefore any circumstance bringing about a change in the food ingested by an organism may affect its germ plasm so as to produce heritable variations.

Independently of this failure to appreciate the real foundation of the new principle, several other remarks of Mr. Meyrick require criticism. Amongst these is the statement that the only discrimination made by *Salix*-feeding Lepidoptera is in general between rough- and smooth-leaved species, and with this is coupled the remark that the influence determining the choice is touch rather than taste. Such views could not possibly emanate from one who has studied the matter in the field. I have recently been investigating the egg-laying habits of the moth *Ypsipetes ruberata*, which abounds here in a tangle of *Salix pentandra* and *S. aurita*. I can assure Mr. Meyrick that the females, when intent on egg-laying, never approach the *S. pentandra* to test the roughness of its foliage, but fly directly to the leaves of *S. aurita*. Moreover, I fail to see how their smoothness or the reverse can affect the choice of food-plant in the case of the lepidopterous *Xanthia flavago*, the coleopterous *Cryptorhynchus lapathi*, or the various Cecidomyids of the genus *Rhabdophaga*, which, with many other species, lepidopterous and otherwise, favour *S. aurita* in the same thicket but lay their eggs on the bark! The facts are, of course, that the two species of *Salix* support two very different faunas.

Further, Mr. Meyrick cannot really imagine that I think that the species employed as examples of allied pairs originated in Britain? I am quite well aware of their range outside our limits, but fail to grasp what this, or the exact locality in which they originated, has to do with the argument. Again, he seems to imply that I consider that a new species has been originated in three generations. No one ever claimed this; the experiments criticised dealt with only one point, that of egg-laying habits. Nevertheless, had Mr. Meyrick understood the principle, or the precise experiments upon which it was based, he would have realised, as is clearly stated in my paper but overlooked by him, that under its workings *Selenia bilunaria* diverged from the parent stock in wing colour and shape, length of larval life, and other features. These achievements may not, in Mr. Meyrick's eyes, go far to explain species-formation in the Lepidoptera, but still they do show how breaks from the original species arise which, in the end, may yield new species. One can expect little more in the lifetime of one worker!

Mr. Meyrick is correct in saying that entomologists have long noted that groups of related species feed on allied or associated plants and probably arose as phytophagous races. However, recognition of these facts is one thing, and an explanation on an experimental basis is another; this explanation I have endeavoured to supply.

As Mr. Meyrick speaks very definitely on the lack of variation, except in size, produced by food amongst the very variable, polyphagous British Caradrinidae, he doubtless has access to experimental work bearing on the point. If so, these experiments are entirely unknown to me, and should be produced for the guidance of fellow-workers. The only pertinent researches on the Caradrinidae with which I am acquainted are those of Hasebroek (*Zool. Jahrb., Abt. f. allg. Zool. u. Physiol.*, Bd. 37, 1919), and that

investigator gives a very definite correlation between the food and certain phases of variation.

In conclusion, I plead for one thing, and that is the removal of the tendency to surround the results of researches in experimental evolution in a cloud of words; what is wanted is not words, but more experiments—and then still more!

J. W. HESLOP HARRISON.

Armstrong College,
Newcastle-upon-Tyne.

Biological Fact and Theory.

It seems to me that all the facts of genetics must be accepted so far as they are supported by evidence, but the antagonism of some biologists is, I think, chiefly due to the complacency with which geneticists assume and assert that their discoveries explain all the important phenomena of biology, including the evolution of adaptations. Prof. T. H. Morgan believes that change of structure has been due to mutation, and that organisms have adapted their habits accordingly. I know of no case of mutation which is in any way parallel to the metamorphosis of the flat-fish or the frog.

The most crucial test, however, of the claims of genetics is the relation of sex-limited characters to the gonadal hormones. Prof. Morgan's view is that "supposing the testis hormone were the cause of strength and activity in the male which would be preserved and developed by natural selection, their secondary influence over other parts of the body would call for no other explanation." Obviously there is no suggestion here of any reason why the hormone should have a secondary influence over other parts of the body, or what determines the special result of the influence. The antlers of a stag have no essential relation to sex or reproduction at all, any more than its legs. Both legs and antlers are part of its hereditary constitution, but the latter depend for their normal development on the testis hormone, the former do not. Female secondary sexual characters, like the milk glands of mammals, are influenced by ovarian hormones. The only connexion with sex which such organs have is an external one, through function and habits. The antlers are only sexual in the use that is made of them in fighting between rival males. The testis hormone is much the same in all mammals; it is certain that there is nothing in the stag's hormone which would produce antlers in a horse or in a man. Why, then, should organs which have functions related to sexual habits be connected physiologically with the gonads or other reproductive organs?

There is nothing in all the facts of genetics or in the refinements of genetical theory, and nothing known about mutations, which throws light upon the relation of sex-limited characters to the sexual habits on one hand and to the gonads on the other.

J. T. CUNNINGHAM.

35 Wavendon Avenue, W.4,
Mar. 10.

THE discussion in NATURE under the above heading appears to me to be based in large measure upon failure to realise the character of scientific knowledge. Such misunderstanding is to be deprecated as being contrary to the interests of further progress in biology. I beg leave, therefore, to reiterate that scientific hypotheses, otherwise known as laws of Nature, are created by the mind of man for purposes of prediction and generalisation. They do not represent absolute truth, and are always liable to be

superseded by new hypotheses which are more widely embracing. The Mendelian laws are no exception. So long as these laws fulfil the function of helping men of science to generalise and to predict they may be held to reflect definite degrees of reality. If, however, they fail to serve this purpose they have no logical justification.

Genes or factors, like atoms and molecules, are concepts invented by the human mind, but if their invention leads to increased complexity of thought rather than to simplification, it is both useless and unwarranted. I am not a geneticist, and to what extent, if any, such a perversion of sound scientific method is being made, it is not for me to say. Nevertheless, I suspect that much of the misunderstanding which has found expression concerning this subject would be resolved by a proper appreciation of the descriptive character of natural science and the limits of its domain.

F. H. A. MARSHALL.

Christ's College, Cambridge,
Mar. 27.

The Continuous Spectrum of β -Rays.

THE continuous spectrum of the β -rays arising from radio-active bodies is a matter of great importance in the study of their disintegration. Two opposite views have been held about the origin of this continuous spectrum. It has been suggested that, as in the α -ray case, the nucleus, at each disintegration, emits an electron having a fixed characteristic energy, and that this process is identical for different atoms of the same body. The continuous spectrum given by these disintegration electrons is then explained as being due to secondary effects, into the nature of which we need not enter here. The alternative theory supposes that the process of emission of the electron is not the same for different atoms, and that the continuous spectrum is a fundamental characteristic of the type of atom disintegrating. Discussion of these views has hitherto been concerned with the problem of whether or not certain specified secondary effects could produce the observed heterogeneity, and although no satisfactory explanation has yet been given by the assumption of secondary effects, it was most important to clear up the problem by a direct method.

There is a ready means of distinguishing between the two views, since in one case a given quantity of energy would be emitted at each disintegration equal to or greater than the maximum energy observed in the electrons escaping from the atom, whereas in the second case the average energy per disintegration would be expected to equal the average energy of the particles emitted. If we were to measure the total energy given out by a known amount of material, as, for example, by enclosing it in a thick-walled calorimeter, then in the first case the heating effect should lead to an average energy per disintegration equal to or greater than the fastest electron emitted, no matter in what way this energy was afterwards split up by secondary effects. Since on the second hypothesis no secondary effects are presumed to be present, the heating effect should correspond simply to the average kinetic energy of the particles forming the continuous spectrum.

To avoid complications due to α -rays or to γ -rays from parent or successive atoms, we measured the heating effect in a thick-walled calorimeter of a known quantity of radium E. This measurement proved difficult because of the small rate of evolution of heat, but by taking special precautions it has been possible to show that the average energy emitted at

each disintegration of radium E is $340,000-30,000$ volts. This result is a striking confirmation of the hypothesis that the continuous spectrum is emitted as such from the nucleus, since the average energy of the particles as determined by ionisation measurements over the whole spectrum gives a value about 390,000 volts, whereas if the energy emitted per disintegration were equal to that of the fastest β -rays, the corresponding value of the heating would be three times as large—in fact, 1,050,000 volts.

Many interesting points are raised by the question of how a nucleus, otherwise quantised, can emit electrons with velocities varying over a wide range, but consideration of these will be deferred until the publication of the full results.

C. D. ELLIS.
W. A. WOOSTER.

Cavendish Laboratory,
Cambridge, Mar. 23.

The Coefficient of Ionisation of a Fused Salt.

It is now forty years since Arrhenius and Van't Hoff put forward two independent methods for calculating the 'coefficient of ionisation' of a dissolved salt. The general concordance of their results provided a firm foundation for Arrhenius's theory of electrolytic dissociation, whilst the smaller discordances have provided material for the development of the later theory of complete ionisation. Since neither of the above methods could be used to determine the coefficient of ionisation of a fused salt, it has been supposed that the problem of determining this coefficient was insoluble. All the data that are required for a formal solution are, however, available for silver chloride at 600° , namely, molecular weight $M = 143.34$, density $\delta = 5.267 - 0.00092t$, $t = 4.715$, specific conductivity $\kappa = 4.48$, viscosity $\eta = 0.01606$ (at 603°).

The normality of the fused salt is $4715 \div 143.34 = 32.9N$; and the equivalent conductivity $\Lambda = 4.48 \div 0.0329 = 136$. A value for the equivalent conductivity, Λ_∞ , of the completely ionised salt, can be deduced from the value in aqueous solutions, for which $\Lambda_\infty^{18} = 54 + 65 = 119$, by making a proportional correction for the increase of viscosity from 0.01056 to 0.01606; the value thus deduced is 78. Since, however, aqueous solutions are often abnormal, more importance attaches to a value deduced from Walden's relation, $\Lambda_\infty \eta_\infty \sqrt{M} = 11.15$, which has been verified for six salts in 29 non-aqueous solvents, as well as for two 'anhydrous' salts in aqueous solution. For silver chloride, $\Lambda_\infty = 11.15 \div 0.01606 \div 12 = 58$. The formal values for $\alpha = \Lambda/\Lambda_\infty$ are then $136 \div 78 = 1.74$ and $136 \div 58 = 2.35$.

Results such as these, indicating an ionisation of about 200 per cent., have perhaps been deduced before, but have been thought to be too absurd to justify publication. They represent, however, an anomaly which merits consideration. The view that the ions of the solvent exhibit an exceptionally great mobility may be true of water, but is certainly not true of other solvents, and cannot therefore be used as a general explanation of the high conductivity which is characteristic of many fused salts. It is therefore more plausible to attribute this effect to the presence of multiply-charged ionic aggregates, resembling the 'ionic micelle' of a colloidal electrolyte, since these would increase both the viscosity and the conductivity of the liquid.

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Larger Aspects of Natural Selection.

THE brilliant researches of Harrison and Garrett, wherein they succeeded in producing heritable modifications in geometrid moths by the use of lead nitrate and manganese sulphate, suggest some reflections on the relation of these phenomena to natural selection. In 1908 I wrote (*Popular Science Monthly*, Dec. 1908, p. 547): "Speaking philosophically, progressive or orthogenetic evolution—the existence of which no naturalist has any ground for doubting—must have a cause external to itself. All probability favours the idea that this did not operate once for all, but has continued in action throughout the ages. It may be found, perhaps, in the susceptibility of the hereditary mechanism to environmental influences of particular kinds, the nature of which remains for the present obscure. These reactions would fall under the operation of natural selection from the very beginning; thus a too susceptible organism would quickly be thrown out of gear and would perish; a too conservative one, unless adapted to practically unchanging types of life, would equally perish. There would be a certain optimum susceptibility, which would be preserved, and would differ for different groups. More than this, certain kinds of susceptibility would be favoured, and being once developed might, like bad habits, become harmful through the accumulation of results, resulting in extinction."

Suppose that we think of mutations as chemical changes induced by certain agents, there is apparently no reason why any of them should be adaptive, or, as we say, 'purposeful.' Yet if we think of millions of such changes, occurring during millions of years, it is evident that natural selection must operate to sort out those substances the reactions of which are more or less likely to be beneficial. This process would not go beyond a certain point, because from the viewpoint of natural selection, it is the race and not the individual that matters. If once in a hundred or a thousand times a favourable reaction occurred, that might suffice; but if it never occurred, the line would probably eventually die out. There is thus some reason for expecting a higher percentage of favourable variations than would be expected on purely chemical grounds.

T. D. A. COCKERELL.

University of Colorado, Feb. 18.

The Control of the Beat of the Fan Segments in *Chætopterus variopedatus*.

WHILE studying regeneration in the tubiculous polychæt *Chætopterus variopedatus* (Renier), some observations were made of a different nature on the rhythmically beating fan segments.

In this worm there are three such segments which beat in a co-ordinated manner, producing a strong current through its tube. The most anterior seems to act as the pacemaker and half accomplishes its beat before the middle fan starts, and this in turn is similarly in advance of the posterior fan. This sequence persists even when the three segments are together isolated from the rest of the worm, but when isolated from each other they beat independently.

In each segment the ganglion is bilobed and the system of muscles, radial and circular, is bilaterally arranged. The intersegmental tissue is greatly constricted and the segments may readily be isolated with little injury, while the ganglion may be extirpated with a needle entirely or on one side only. When destroyed on both sides the contractions cease, but if on one side, the contractions of that side only

are stopped, the other side continuing to beat in a relatively normal manner.

The anatomy of these structures has been described in detail by Joyeux-Laffaie (*Arch. Zool. exp. et gén.*, 8, p. 244; 1890). Thus each half of a fan segment acts as a single nerve muscle system under the control of the corresponding half of the ganglion, the action of which, however, is synchronised with that of the other, while the whole is subordinated, in the case of two out of three, to the influence of the segment immediately in front of it.

A further point of interest is that such isolated fan segments may readily be kept alive and beating in a stream of well-aerated sea water for four or five weeks, and so form promising material for further experimental work.

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Numerical Solution of Algebraic Equations.

IN his account of Newton's work in pure mathematics (*NATURE*, Mar. 26, Suppt. p. 42), Prof. Mordell directs attention to the method of solving the cubic equation introduced by him. This method is in principle precisely that usually attributed to Horner; but the form quoted by Prof. Mordell is much more convenient in application than that given in most modern works on algebra. In the original form of the method, when we want to reduce the equation by 2, we replace y by $y + 2$, and rearrange in powers of y . In the usual form we divide three times by $y - 2$; thus in finding the coefficient of the second term we add 2 to the original coefficient three times instead of simply adding 6. The introduction of division resulted in a great increase in labour instead of a reduction. If there is any doubt, try it both ways and see!

The device of multiplying the roots by 10 is also, I think, undesirable, but less so. I have found it easier to dispense with it, noticing when the highest term has become too small to affect the answer. The whole equation should be multiplied by a power of 10 at intervals, so as to keep the coefficient of the first power of the unknown between 1 and 10.

Last year I had occasion to mark a number of solutions of a cubic equation produced in an examination. They included, to my surprise, a number by Tartaglia's method, which were almost as short as those obtained by the Newton-Horner method at its best. Tartaglia's method, of course, replaces the problem of solving the cubic by that of finding two cube roots, and in the absence of tables the extraction of one cube root is as difficult as the solution of the original equation. But tables of logarithms avoid this difficulty. For numerical work the disadvantages of Tartaglia's method, using tables, are first, that it does not work in the "irreducible case," and second, that it is not a particular case of a general method applicable to equations of all degrees.

HAROLD JEFFREYS.

St. John's College, Cambridge.

Behind the Divining Rod.

I do not quite understand why Dr. Mill should assume (*NATURE*, Mar. 26, p. 458) that the dowzers of my acquaintance are 'ignorant charlatans,' and they certainly have never 'impudently challenged' my studies, scientific or not. For my own part I regard these honest folk simply as self-deluded enthusiasts, and trust that no one will see in this a euphemistic equivalent; I am quite sure that at

least one of my scientific friends would feel hurt if the term 'ignorant charlatan' were applied to his pet dowser.

It is fortunate that Dr. Mill knows an honest man of whose powers he is convinced. Here there is good material for serious investigation. Experiments might be devised to determine whether the subject responded to the influence of flowing water, but fortunately stationary metals, such as gold or silver, could be substituted for flowing water. This would simplify the procedure. I would suggest that a handful of similar coins, say French francs, which resemble gold, and English sovereigns, should be shuffled and then distributed into wooden boxes, all of the same size and outward appearance. The whole operation to be so conducted that the investigator himself should be ignorant of the location of the genuine noble metal and its simulacrum. This would exclude any telepathic influence. Should the dowser by 'spotting' the sovereigns emerge successfully from this test, there would then be good grounds for extended inquiry.

I may add that I am familiar with the one-sided presentation of the question which we owe to the advocacy of the late Sir William Barrett, and am unable to regard its evidence as convincing.

W. J. SOLLAS.

University Museum, Oxford,
Mar. 27.

Prof. Carl Runge.

MANY of those who attended the meeting of Section A of the British Association at Oxford last August, distinguished as it was by the presence of so many spectroscopists and atomic theorists from various countries, will remember the peculiar pleasure, and one might say affection, roused by a really beautiful speech from that veteran mathematical spectroscopist, Prof. Runge; in which he expressed gratification at the brilliant results which were pouring forth on all sides as the outcome of earlier work in which he and some German colleagues had taken a leading part. In the peroration of that speech he pronounced on himself a touching *Nunc Dimittis*, which, alas, only five months later has been justified, though, as we learn from the obituary notice in *NATURE* of April 9, p. 533, he had attained only seventy-one years of age.

Surely Runge felt the welcome which we gave him; and I will only quote, without comment, the concluding words of that obituary notice: "His son was killed early in the War."

OLIVER LODGE.

April 9.

The Behaviour of Cultures of *Leishmania* sp. in *Phlebotomus papatasi*.

WE must apologise for two errors in the note on the behaviour of cultures of *Leishmania* in *P. papatasi* (*NATURE*, Jan. 8, p. 48). Sandfly No. 172 was not laboratory bred but was caught in Jerusalem, but as the infection rate in sandflies in Jerusalem is either nil or so small as to be negligible (not a single example of an infection was found during two years' dissection), this makes no difference to the conclusions deduced from the experiment. The inoculation was performed on Sept. 20, and not Sept. 26.

S. ADLER.

O. THEODOR.

Microbiological Institute,
Hebrew University,
Jerusalem, Feb. 14.

Philosophical Foundations of Quantum Theory.¹

By Dr. P. JORDAN, University of Göttingen.

THE development of physics in the last decades has repeatedly raised epistemological questions of fundamental importance. Thus in the theory of relativity the problem of space and time received at least a temporary clarification. New questions have arisen in connexion with the quantum theory, and particularly the question of the existence of causal laws in elementary physical processes. Is the condition of an atomic system completely determined, or are there gaps in its determination?

Physicists no longer doubt that this question of the existence of a complete causal determination can only be settled by experience, and that causality is not an *a priori* necessity of thought. Certainly some degree of determinism is an essential condition for the possibility of physical science, as it is for any ordered and intelligible existence; and fortunately we have, if we confine ourselves to macroscopic phenomena, an apparently universal and trustworthy determinism. But for atomic phenomena this implies only a statistical determinism. The question of the causal necessity of the laws of an individual atom thus remains.

Before we attack this point it will be useful to give the notion of determinism a more precise consideration. The physicist cannot be satisfied with the approximate idea that we have of the meaning of this word. Nor is he interested in the metaphysical significance that some philosophers give it. For the physicist the definition of causality or determinism means the specification of conditions by which its existence may be experimentally established. This shows that the physical definition must continually change in accordance with the basis of our theories and facts and experimental methods. Let us consider first the rôle of causality in the classical physics of the field.

The contention of this classical physics is that the physical world may be described—and we use the word describe in a more or less purely geographical sense—by the specification of certain measurable quantities—fields, potentials, etc.—for every point of a four-dimensional region of space-time; and then the causal determinism consists in this. Let us consider a bounded volume of the space—say a parallelepiped. We shall not consider what modifications would be introduced into these considerations by taking complete account of the relativistic relations of space and time; but this would, of course, raise no difficulty. At a certain time—for example, at eleven o'clock—let the physical conditions inside the box be completely known and measured. Further, let the physical conditions of the entire surface of the box be specified from eleven until twelve o'clock. The physical phenomena in the whole box will then be

uniquely determined from eleven to twelve o'clock. Thus, if we at any other time and place repeated the experiment, with the same initial conditions and the same course for the surface conditions, all of the phenomena inside the box would automatically be reproduced. Within a certain period of time—of the order of magnitude of the dimensions of the box divided by the velocity of light—the phenomena inside the box are independent of those on the surface.

These assertions are susceptible of experimental proof. Of course, we have to suppose at the beginning that the initial state within the box is not so complicated that its complete physical investigation would be entirely impossible. Thus we should have to exclude the case that there is a living organism in the box; for the notion that one could measure exactly the physical conditions is in this case not in accord with the experimental practicability. Thus the notion of determinism must be formulated differently for biology and for physics.

Let us therefore confine ourselves to a consideration of physical determinism. We may remark that this determinism is of an extraordinary kind; it is not at all equivalent to the mere existence of physical laws—the existence of mathematical relations between physical quantities. Moreover, we have here a peculiar asymmetry between the special and temporal co-ordinates; by this principle of determinism two temporally separate regions may influence each other physically; two spatially separated regions cannot.

The theoretical justification of this determinism arises from two circumstances. We shall mention these here without entering upon a mathematical proof that they really furnish this justification. In the first place, the physical laws—that is, the mathematical relations between the components of the field—are differential equations, and, in fact, to a first approximation, principally linear partial differential equations of the second order. In the second place, for the simplest four-dimensional geometry, in which the Pythagorean theorem remains valid, one must use, not the time itself, but the imaginary time, as fourth co-ordinate. If, instead of this, the four-dimensional manifold had four real dimensions, and the differential equation of physics remained unchanged, then we should have a much more complete determinism: one would then be able to deduce the state of any region of space-time from an accurate knowledge of any other specific region. If, on the other hand, the world had two real and two imaginary dimensions, there would be no determinism left. For in this case it would be possible for new motions suddenly to arise inside a box, even though there were no cause for them either within the box or at the boundary. This, then, is the significance of determinism for the physics of the field. It is not itself

¹ *Habilitationsvortrag* at the University of Göttingen. Translated by Mr. Robert Oppenheimer. The author is very much obliged to Mr. Oppenheimer for his careful translation.

a natural law; the natural laws are the differential equations that lie at the basis of the physical field. It is a mathematical conclusion from these natural laws, a theorem from the mathematical theory of hyperbolic differential equations which has been applied to the laws of physics.

It is on this account that one must be prepared to lose this determinism in the transition from classical physics to the quantum theory. For just those physical assumptions are here discarded which we have noted as theoretical support for the existence of determinism. Even the *description* of 'physical reality' cannot, as we now know, be given in terms taken from classical physics. Physical quantities are *not* continuously propagated through space; physical motions are not invariably continuous; there are elementary discontinuities, there are *quantum jumps*. What remains of determinism is not necessarily more than statistical. If we work with a great many similar atoms, or repeat very often experiments with a few, then we always get a result in agreement with the principle of determinism. We have seen before that physical determinism and physical laws were not co-extensive. We must, therefore, remark that in this case what we have said for determinism holds also for all physical laws. All we know at present are laws that are essentially statistical.

In recent times important advances have been made in the discovery of these laws. One can now, for example, compute (in principle) the spectrum connected with the motion of electrons in an atom with the same assurance as, on classical dynamics, one could calculate the motions of the planets. But in spite of the analogy between the calculations, there is an important difference in the interpretation of their results. The classical calculation gives us information about our specific system of planets. The quantum theoretical calculation does not, in general, tell us anything about a single atom, but only about the mean properties of an assembly of similar atoms. One can, it is true, calculate the energy of a single atom in a certain state on the quantum theory. But that is only because the energy is the same for all atoms in this state, and the individual energy coincides with the mean. But if we consider the behaviour of the atom under external influences—*e.g.* incident light or electronic collision—we get a result that cannot be interpreted as showing that, for specific values of the phases, specific phenomena occur. We can only interpret the results of the calculation as follows: there is an assignable probability that the atom will do one thing, and an assignable probability that it will do any other.

We have a similar situation in optics. Classical optical theory yields, it is true, all interference phenomena in perfect accord with experiment. But the calculated intensity of light at a given point does not represent the actual intensity. The classical wave-field clearly only gives the probability that a quantum will reach the point. Moreover, one can find waves accompanying a material corpuscular beam which in some respects bear the same relation to the corpuscles as the light waves

to the quanta. Here again we see the purely statistical nature of the present quantum theoretical laws.

We shall therefore direct our attention, not to the discrete, discontinuous details, but to the corresponding probabilities. The introduction of these probabilities brings us formally back to continuous variables, and thus, in a very important respect, to classical terms. We are therefore led to suppose that there is a principle of determinism for these continuous probabilities which is not very different from the classical principle. This is, in fact, the case, but in a somewhat more abstract way than in the classical theory.

It is known that Schrödinger, independently and by methods of his own, was able to give a formulation of the quantum theory which turned out to be mathematically equivalent to the matrix theory based on Heisenberg's ideas. He thus discovered mathematical relationships in the quantum theory, which had not before been explicitly developed. These were, it is true, implicitly involved in the matrix theory; but their formulation represents an important addition to quantum mechanics.

In connexion with these formulæ, Schrödinger also tried to develop a new physical basis for the quantum theory. His interpretation differs fundamentally from that of Planck, Bohr, and Einstein, from the classical quantum theory based on stationary states and quantum jumps. In it he tried to return to quasi-classical conceptions, in which there were no longer any discontinuities, and in which, therefore, the classical principle of determinism was still valid. All other scientific workers, however, who had taken part in the development of quantum mechanics, were unable to accept these speculations of Schrödinger. They were sure that the new conceptions would have to be interpreted physically in close analogy with the older notions of stationary states and quantum jumps, and with Heisenberg's theory; and that Schrödinger's relations would, like those of the matrix theory, have to be interpreted statistically. A particularly clear and satisfactory formulation of the statistical interpretation of Schrödinger's theory has been given by Born, and in what follows I shall base my argument on this.

The essential purport of Schrödinger's theory is this: that quantum mechanical laws, which were given in the matrix theory as a system of infinitely many equations with infinitely many unknowns, can instead be expressed by quite ordinary differential equations. Formally, this takes us back very close to the classical theory. Born's answer to the question as to how it is possible to represent anything in the discontinuous confusion of quantised atomic processes by differential equations, is that the function which is to satisfy the differential equation is a probability.

We shall now consider more closely this probability function, and try to make clear the analogy with the classical situation. Consider a mechanical system of two particles and six degrees of freedom; let the continuous co-ordinates of the particles be x_1, x_2 to z_1, z_2 . We now construct a space more or

less like the classical phase space, but with only half as many dimensions: a configuration space. In our example it is a six-dimensional space with the co-ordinates x_1 to z_3 . We can represent the state of the system when it has specified co-ordinates and arbitrary momenta by a point in this space, which we shall call the system-point. Classically the system-point would describe a certain trajectory. But we cannot know beforehand, if we observe it at a given time at a given place in the space, how it will move, for the system-point only tells us the co-ordinates, not the momenta; of the two particles. All one can determine is the probability that the point will move in a given direction.

In the classical theory we can translate this statistical prediction into an exact one, since we can observe not merely the position but also the velocity of the system-point. But, according to Pauli, this is just the point where quantum and classical theory differ. If we can observe the co-ordinates of a quantum mechanical system—and here we use *co-ordinate* in a generalised sense, so as to include, say, the energy or the quantum numbers—then the momenta conjugate to these co-ordinates are intrinsically not observable. All we can do, therefore, is to take over the statistical problem from classical mechanics, and probably derive the solution from Schrödinger's differential equation. I say *probably*, because considerations which follow out these speculations are not yet completed.

The following question, however, which is closely connected with the one we have been considering, can be regarded as solved by the work of Born and Pauli. Suppose we know the energy and quantum numbers of our system—or, more generally, suppose we know the probability that the system is in any of the stationary states; what is the probability that the system-point is at a given place in the configuration space? We can answer this question at once if we know the Schrödinger wave function.

This Schrödinger function—a function of the six variables x_1 to z_3 and the time—satisfies Schrödinger's fundamental differential equation. For this probability function we can again formulate a principle of determinism. For this, of course, we have to take a box, not in ordinary space, but in the six-dimensional configuration space. Then the principle is precisely the same as in the classical theory, except that in place of the measurement of the field inside and on the boundary of the box we must now write the measurement of the Schrödinger probability function.

To recapitulate: classical physics described the world in terms of quantities continuously propagated in space and time. The quantum theory describes the world in terms of an abstract, many-dimensional configuration space, and the number of dimensions is proportional to the total number of particles in the world. In this abstract space we have again the propagation of continuous quantities; but these no longer tell us directly

about the single atomic phenomenon, but rather about the probabilities of quantum processes. Determinism—not as a metaphysical distinction from chance, but in the physical sense explained above—has the same formal validity in both theories.

Of course, one can transform the quantum theoretical laws back to ordinary space, but their form is then very complicated, for the abstract space leads to the most suitable formulation of the problem. But one can still say that the complicated 3-dimensional predictions justify, roughly, what I said before—that in the mean the old 3-dimensional determinism still holds.

We have seen how it is possible, by the use of averages and probabilities, to eliminate the elementary discontinuities in physical processes, and to find relations which can be formulated mathematically by the customary methods of classical physics, methods adapted to the study of intrinsically continuous quantities. In this respect quantum mechanics constitutes a more precise version of Bohr's correspondence principle. Bohr always (it will be remembered), even in the zenith of our belief in integers, insisted that we try to establish a formal analogy with classical theory by a consideration of mean values.

Now, however, we shall return to the problem of the discontinuous elementary phenomena; we shall consider the question of how much we can say about these phenomena, granted that we can find the solution of any problem in averages, whatever their formulation. The answer to this question is not nearly so simple as one might expect; and I should be guilty of a very superficial treatment of my subject if I were not at least to point out some of the difficulties that occur in connexion with it.

Let us first of all examine the matter from the empirical point of view. One might suppose that experiments would in no case give us anything but average values. An interesting lecture given by Prof. Zernicke last summer on the Brownian movement, and in particular on the researches of Ising in Sweden, showed clearly the impassable limits to an improvement of the technique of physical measurement. It is impossible to increase the accuracy of a galvanometer, for example, beyond a certain assignable limit; it is impossible because of the Brownian movement in all parts of the apparatus. The needle, the fibres, the housing, the surrounding air, all consist of atoms in irregular thermal agitation; and the current that passes through the galvanometer consists of electrons, and therefore shows irregular variations of intensities, which can only be statistically computed and limit the efficiency of the instrument in an analogous way. When we remember that this is the case with all our apparatus, and that it all 'rattles about' in this way, we may be tempted to think that the experimentalist is quite as incapable of observing elementary processes as the quantum theorist is of predicting them. But there is a drastic method of avoiding Brownian movement. The theorist gives

the simple recipe: make the experiments at the absolute zero. Luckily, experimentalists have discovered an equivalent but less uncomfortable way. By working with particles which have a vast store of energy, *e.g.* a fast α -particle, they make the thermal agitation of the atoms negligible. And we can, in fact, largely because of the work of C. T. R. Wilson, actually observe the fate of a single α -particle, follow its trajectory, and determine the moment when the trajectory ends in a quantum jump.

The time of a single quantum jump is thus under certain conditions a measurable quantity. What predictions can our theory make on this point? The most obvious answer is that the theory only gives averages, and can tell us, on the average, how many quantum jumps will occur in any interval of time. Thus, we must conclude, the theory gives the probability that a jump will occur at a given moment; and thus, so we might be led to conclude, the exact moment is indeterminate, and all we have is a probability for the jump. But this last conclusion does not necessarily follow from the preceding one; it is an additional hypothesis. It is this hypothesis which Bohr, Kramers, and Slater tried to carry out in their theory of radiation. They realised quite clearly that this hypothesis must leave the conservation of energy as only a statistical theorem. This conclusion, of course, was disproved by the beautiful experiments of Geiger and Bothe and of Compton. We can now assert that if an atom emits light, and that if this light is propagated, unhindered by interference, to another atom, where it is absorbed, then the quantum jump of the absorbing atom occurs after a time which corresponds exactly to the distance between the atoms. Thus we see that, in some cases at least, the time of a quantum jump is determined.

One might be tempted to say: the time is determined in so far as its determination is required for conservation of energy—and no further. But this two-sided explanation is too indefinite to be of any use in complicated cases, *e.g.* where interference occurs. Another method of overcoming this difficulty was tried some time ago by Wentzel: since in our example the absorption is fully determined by the preceding emission, we could regard the two processes together as a single quantum process, and then hope that such processes would be statistically independent of each other. But this way, too, does not seem to lead to any simple formulation.

It is thus very significant that in Pauli's above-mentioned formulation nothing is said about the probability of a transition—for we saw that this could not lead to independent probabilities. What the theory does specify is the probability that the system-point be at a given place in the configuration space. One might therefore hope that these considerations would lead us to independent elementary physical probabilities.

Although we can in principle compute all probabilities on the quantum theory, a very serious

problem still remains unsolved. For definiteness let us take a simple example. Let us throw two dice; and let us observe empirically that a 1 and a 3 occur together just as often as a 4 and a 5, and twice as often as two 2's, and so on. Now if we had a theory which made it possible to compute these probabilities in some very complicated and abstract way, we might be satisfied. But we are really only satisfied when we can reduce the theory to this form; for each die each of the six faces is equally probable; and the dice are statistically independent. Only when we see this do we feel that we really understand the matter.

Now, for the dice we clearly should never think of using any other theory than the one just given. But in the quantum theory the matter is different: we can at present compute all probabilities; but we cannot understand any of them. We could only say that we understood them if we had translated the calculations in configuration space into the following terms: In some cases there is no condition on what happens; either this or that can happen: they are equally likely, and what happens in one case has nothing to do with what happens in others.

In other words, we must reduce the quantum theoretical probabilities to independent elementary probabilities. Only then can we say that we really understand the laws: and only then can we tell under what conditions the time of a transition is determined. Only then can we know exactly what is causally determined, and what is left to chance.

In conclusion, let me try to bring out one more point. We have just been taking for granted that the future analysis of quantum theoretical probabilities would lead to the result that certain elementary processes were not determinate, and could happen equally probably in a variety of ways. But in fact that is not at all self-evident. The circumstance that quantum laws are laws of averages, and can only be applied statistically to specific elementary processes, is not a conclusive proof that the elementary laws themselves can only be put in terms of probability.

We can thus put in this final form our question, "Does modern physics recognise any complete determinism?"—a question which we have seen to split up into several distinct ones. Will the elementary laws for which we are looking be laws of determinism or of probability? Will it ever happen that the time of a quantum jump is undetermined?

Probably we shall find that an incomplete determinism, a certain element of pure chance, is intrinsic in these elementary physical laws. But, as I have said, a trustworthy decision will only be possible after a further analysis of quantum mechanics on the lines laid down by Born and Pauli. Perhaps I might add that pertinent considerations have been recently carried through in Copenhagen, and here in Göttingen, in what, I think, is a very promising way.

The Lister Centenary Celebrations in London.

ON April 5, 1827, there was born at Upton, in Essex, one who was destined to achieve more for the happiness of mankind than was vouchsafed to almost any other human being. Joseph Lister was the fourth child and second son of Joseph Jackson Lister, a prosperous wine merchant and also an eminent scientific worker, and fellow of the Royal Society, to whom we owe the production of the achromatic lens. He studied medicine at University College, London, and in 1852 took the M.B. degree and became also a fellow of the Royal College of Surgeons.

Acting on Prof. Sharpey's advice, Lister then went to Edinburgh, where he became closely associated with the famous surgeon James Syme, and in 1856 he married Agnes, Syme's eldest daughter. In 1860 he was appointed professor of surgery in the University of Glasgow, a post which he held for nine years, only leaving when he was elected to the Edinburgh professorship. In 1877 he was appointed to the chair of clinical surgery at King's College, London, and held this post until 1893. In 1883 he was made a baronet. In 1895 he became president of the Royal Society, and during his tenure of this office, was created a peer, on the occasion of Queen Victoria's second jubilee. At the time of King Edward's coronation he became a member of the Order of Merit. In 1908 he retired to the small seaside town of Walmer, in Kent, where four years later, on Feb. 10, he passed peacefully away, at the age of eighty-four. Lady Lister had predeceased him by some nineteen years.

This bald sketch of Lister's life will enable readers to follow more clearly the account which follows of the celebrations during the Lister centenary week in London, in which the speakers dealt with the various aspects of his life and work. For further details those interested may be referred to the chapter on the Life of Lord Lister in the Handbook of the Lister Centenary Exhibition at the Wellcome Historical Medical Museum.¹ The Glasgow period is dealt with by Sir Hector Clare Cameron,² and in the centenary contribution entitled "Lister and the Lister Ward in the Royal Infirmary of Glasgow,"³ wherein accounts are given of the beginnings of antiseptic surgery and of the fruitless efforts made by scientific men the world over to save the Lister ward from demolition: the Edinburgh period is described in interesting detail by Dr. J. R. Leeson.⁴

The centenary celebrations commenced in London on Monday, April 4, when about a hundred delegates from all parts of the world were received by the King at Buckingham Palace. An address was presented by Sir Ernest Rutherford, president of the Royal Society, to which His Majesty replied.

¹ Lister Centenary Exhibition at the Wellcome Historical Medical Museum: Handbook, 1927. (The Wellcome Foundation, Ltd., London.)
² "Centenary of Lord Lister, 1827-1927. Reminiscences of Lister and of his Work in the Wards of the Glasgow Royal Infirmary, 1860-1869. By Sir Hector Clare Cameron. (Glasgow University Publications, 6.) Pp. 45+3 plates. (Glasgow: Jackson, Wylie and Co., 1927.) 1s. net.

³ "Lister and the Lister Ward in the Royal Infirmary of Glasgow: a Centenary Contribution." Pp. xvi+132+28 plates. (Glasgow: Jackson, Wylie and Co., 1927.) 12s. 6d. net.

⁴ "Lister as I knew Him." By Dr. John Rudd Leeson. Pp. xii+12+7 plates. (London: Baillière, Tindall and Cox, 1927.) 8s. 6d. net.

In the afternoon the Listerian Society held a meeting at King's College Hospital, with Mr. Arthur Cheate in the chair. Sir Watson Cheyne, in the course of his address, said that the outcome of Lister's work was perhaps more widespread than that of any of the great statesmen, generals, philosophers or religious teachers, and its influence on mankind was not limited to any country or race. Sir Watson described how he himself, with a few other chosen associates, accompanied Lister from Edinburgh to King's College Hospital as apostles of the new methods in surgery. Like all pioneers, Lister met with much opposition in promulgating his views, and London was probably one of the last places in the world to accept them. The speaker referred also to Lister's conscientiousness, both in the treatment of his patients and in his lectures: for the latter he endeavoured, by his own experiments, to prove any points which appeared to him doubtful. The difficulties in advising treatment were greatly enhanced by the fact that only some surgeons practised antiseptics; thus an operation which might be justifiable, performed antiseptically, would be contra-indicated if the additional risk of sepsis had to be run.

In the evening a reception was held at the Royal Society of Medicine, when Sir St. Clair Thomson gave an address entitled "A House Surgeon's Memories." He said that Lister achieved more for mankind than all the surgeons from the beginning of history. For centuries the results of surgical wounds had scarcely improved at all: but Lister's teaching has saved more lives than all the military heroes of all the ages have destroyed. Sir St. Clair was associated with Lister at King's College Hospital; at his inaugural lecture he described experiments showing that neither milk nor blood had any inherent tendency to putrefaction, and if drawn under what we should call 'sterile' conditions, would remain free from putrefaction indefinitely. Lister's classes were strangely neglected by the students, probably owing to the fact that his work did not find favour with the examiners of the period, so that his teaching was of little use in helping a man to pass his examination. London was not backward in demonstrating that a prophet was not without honour except in his own country. But in ten years' time, with a new generation of surgeons springing up, Lister's technique had become widely followed. Sir St. Clair referred also to his scientific spirit. In 1875, Queen Victoria, to whom only one side of the question had been presented, wrote to Lister asking him to take action to suppress vivisection. Lister wrote to the private secretary as follows: "I should deeply regret that I cannot see my way to comply with this request, were I not persuaded that my duty so would not promote the real good of the community, which I know to be Her Majesty's only object in the matter."

On Tuesday, April 6, the delegates to the centenary celebrations were received by the Prime Minister in the Great Hall of the British Medical

Association, Tavistock Square. Sir Ernest Rutherford was in the chair and was accompanied by Mr. R. G. Hogarth, president of the British Medical Association. Sir Ernest, in the course of a few introductory remarks, said that it was not necessary to be a specialist to recognise the debt the whole world owes to Lister's discoveries and his single-minded devotion to the cause of suffering humanity. Mr. Baldwin recalled that it was two years after Lister came to London, and before he had obtained that recognition which was afterwards lavished upon him, that at an international congress in Amsterdam, he was greeted by the chairman in these words: "Prof. Lister, it is not only our admiration which we offer you; it is our gratitude and that of the nations to which we belong." These words were echoed years later, not by an Englishman but by an American, at a dinner of the Royal Society, when Mr. Bayard, the American Ambassador, in proposing Lister's health, said: "My lord, it is not a profession, it is not a nation, it is humanity itself which with uncovered head salutes you." The Prime Minister said that they had come to greet the memory of a great master workman in his own craft, the man who pursued his science empirically and who also, by applying newly discovered knowledge to practical problems throughout his life, brought more relief and comfort to the human race than almost any man who has lived. At the same time, as a statesman he (Mr. Baldwin) felt he could pay tribute to Lister's character, his wonderful simplicity and integrity, for he was a man who loved the truth, gentle and filled with charity and self-devotion, a man with never a mean thought.

After the Prime Minister had greeted each delegate, Prof. Henri Hartmann of Paris and Prof. Max Ritter von Gruber, of Munich, spoke on the influence Lister's practice had on pathological and surgical science and practice in their own countries.

On Wednesday, April 6, a thanksgiving service was held in Westminster Abbey, in the morning, which was attended by the delegates, and by representatives of the Royal Society and of the Royal Colleges of Surgeons and Physicians. The service was conducted by Canon Nixon, and the Bishop of Birmingham, Dr. E. W. Barnes, delivered an address. He said that Lister owed much to his Quaker ancestry, and perhaps it was not fanciful to see in the ability of his father, and in a touch of Celtic imagination derived from his mother, the source of his genius. He certainly received in his home life influences which made his character the worthy servant of his genius. Throughout his life he retained the Christian faith of his childhood: at the time of his marriage he ceased to belong to the Society of Friends and became, like his wife, a member of the Scottish Episcopal Church. He combined the hope of personal immortality with faith in the goodness of the Creator, and when his life was drawing to a close, he publicly expressed his conviction that "there is no antagonism between the religion of Jesus Christ and any fact scientifically established." He was convinced of

the power of goodness and was a loyal servant of the truth. Dr. Barnes continued by saying that man differs from all other animals in possessing a soul. Is it possible that, by virtue of the mental powers which set man apart, he will conquer disease and pain and thus, in the end, prepare the way for a Kingdom of God upon earth? Will medical and moral victories combine to make human life equal to human hopes? The achievements of great men give substance to our hopes, and we thank God, he said, for the example of a single-minded devotion to science which will inspire others to work for the welfare of the human race.

In the afternoon a meeting was held at the rooms of the Royal Society of Medicine, at which tributes were paid to Lister as physiologist, bacteriologist, and surgeon. Sir Ernest Rutherford was again in the chair.

Sir Charles Sherrington spoke on Lister as a physiologist. He said that Lister's first paper, published when he was twenty-five years of age, was on the "Contractile Tissue of the Iris," done with the microscope, which he used for the study of function rather than of form alone. It was only natural, considering the interest his father took in optical science, that young Lister should employ the microscope in his first research. His second paper was on the involuntary muscle cells of the skin, and it is of interest to note, in connexion with his later characteristics, certain expressions used in these papers, such as "the grand discovery of plain muscle cells" and "the beautiful muscle of the iris." These phrases throw light on the eagerness with which he threw himself into research. These papers reveal points in Lister's original nature: a catholic enthusiasm for research and a restless testing of authority by observed fact: in short, a fear of nothing except of missing the truth. Four years later, a further paper on involuntary muscle appeared, in which Lister proved, once again, its cellular nature; but this was the last on this particular theme: his interests had turned to surgery and pathology and his physiological research became merely collateral to the pathological studies engaging his main thoughts. His earlier work in this field was related to the problems of inflammation, and dealt with the nervous control of arteries and the inhibitory nature of certain visceral nerves; but after the year 1859 none of his work was directly related to physiology. Yet by means of his work on antiseptics and by the development of his surgical technique he enriched physiology with the contribution of enhanced means towards its own cherished aims. Without Lister's surgical principles, how could Pavlov have achieved his epoch-opening study of the digestive processes, or Ferrier initiated his work on localisation of cerebral function? How could the Toronto physiologists, barely four years ago, have bestowed upon diabetic sufferers that merciful remedy insulin? The experimentalist indeed owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to. At the same time, while

helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Thus it is that through the years to come, after indeed the actual physiological papers may have become matter chiefly for the historian and antiquarian, Lister will still receive his meed of commemoration from the physiologist and experimentalist. It is therefore with peculiar gratitude that the physiologist brings his tribute of admiration and veneration to the memory of one great even among the greatest of the benefactors of humanity, Joseph Lister.

Prof. William Bulloch then gave an account of Lister as a pathologist and bacteriologist. The main part of the address covered the same ground as that of the article entitled "Some Aspects of Lister's Scientific Work," which Prof. Bulloch contributed to our issue on April 9, p. 531.

In the third and final address Sir Berkeley Moynihan paid an eloquent tribute to Lister as a surgeon. He said that seldom is a great discovery the product of one man's mind: in the work of other men it has ancestors—forerunners possessing one or more attributes the final and felicitous association of which within new work constitutes new truth. The claim may then arise that those who have revealed isolated and antecedent truths have priority in the final discovery. Such truths are, however, only progenitors, with no claim to be regarded as their own descendant—the new truth itself. Lister did for the craft of surgery what John Hunter had done for its science. When he first began his work, operations were few owing to the danger of putrefaction in the wound, followed in almost all cases by death. Even the simplest operation was a great anxiety to the surgeon, from the ever-present fear of suppuration developing. Lister's discovery was very gradual. His earliest surgical inquiries dealt with inflammation and the coagulation of the blood, but his chief interest lay always in the problem of the healing of wounds. He had arrived at the conclusion that the essential cause of suppuration in wounds was decomposition brought about by the atmosphere acting upon blood and serum retained in them, or upon portions of destroyed tissues, but since oxygen was considered to be the agent causing this putrefaction, it appeared hopeless to devise a method by which suppuration might be prevented. But when Pasteur had shown that putrefaction was caused by minute organisms suspended in the air, a method of prevention at once came to his mind, to apply to the wound some substance which would destroy the micro-organisms without injuring the body tissues. Still later he developed a method by which the organisms might be destroyed before they had even entered the wound. Around every step of his advance fierce controversy raged; the scepticism of early contemporaries was stupid, unimaginative, and petty. But the history of science frequently discloses this bitter opposition to new truths, as in the case of Harvey and Pasteur and other famous men. Lister's answer was unflinching continuance in inquiry and experiment,

with demonstration of his results. The heavily infected wounds seen during the War has enabled us to realise much more acutely the problems which confronted Lister at the beginning of his work, and has increased our admiration for the way he overcame them. Although Lister sought to destroy the organisms which might enter a wound, yet he was not blind to the natural resistance of the body's cells to infection, so that a natural step was the development of aseptic surgery in which organisms are prevented from entering a wound so far as possible, and any that do can then be dealt with by the body's own bactericidal forces. There is no real clash between 'antiseptic' and 'aseptic' methods, for no surgeon ever practised with success a method which omitted the use of agents for the destruction of organisms. The consequences of Lister's work were many and far-reaching: when the few operations which were practised in those days became safe it was obvious that others might be attempted, and thus has grown up the science and art of modern surgery. Ovariectomy was one of the first operations to be made safe; and once it was found that the abdomen could be safely opened, a vast field of usefulness was before the surgeon. The cranial and thoracic cavities then became accessible to surgical methods of treatment, so that nowadays almost all parts of the body can be safely submitted to surgical operation. Not the least of the debts we owe to Lister is the curability of cancer if complete surgical removal is practised in the early stages of the disease. We may almost claim that the full effect of Lister's work is now accomplished. The art of surgery is far in advance of the sciences on which its future progress depends. The great search must be for methods of applying new discoveries in other sciences to the study of disease.

To the honoured dead we raise our monuments; but Lister's living and enduring memorial is a great and even greater multitude of men, women, and children of every nation, of every race, of every creed, through his mercy and by the skill of his most gentle hand relieved from infirmity and suffering and sorrow and made for a time triumphant over death itself. It is immortal Lister we salute to-day, the supreme benefactor of mankind.

In concluding, attention must be directed to the Lister Centenary Exhibition at the Wellcome Historical Medical Museum in Wigmore Street. The collection was opened by Sir W. Watson Cheyne, in the absence of Mr. Wellcome, on the evening of Thursday, April 7. The most striking exhibit is probably the section of the old Lister Ward from the Glasgow Royal Infirmary, in which Lister practised his antiseptic system of surgery between 1861 and 1869. The furniture and fittings are from the Ward when it was demolished in 1924. The collection comprises an extensive and highly interesting series of exhibits relating to all aspects of Lister's life and work, including instruments and apparatus used by him, reproductions of various experiments performed by him, his diplomas and certificates, and photographs of those associated with him in his work.

Obituary.

DR. F. B. POWER.

DURING his stay in Great Britain, Dr. Frederick Belding Power made many friends among chemists, who will regret to learn of his death from heart failure in Washington on Mar. 30. He was born at Hudson, in New York State, in 1853, and at the early age of thirteen years was apprenticed to a local pharmacist. This direct connexion with pharmacy was continued up to 1874, when, after securing his diploma at the Philadelphia College of Pharmacy, Power went to Strasbourg, where he took his Ph.D. in 1880. Returning to the United States, he held, among other teaching appointments, the professorship of materia medica and pharmacy at Wisconsin University.

Among his fellow-students at the Philadelphia College of Pharmacy was Mr. Henry S. Wellcome, and when the latter established the Wellcome Chemical Research Laboratories in 1896, he invited Dr. Power to become the first director. From 1896 until 1914, Power and his assistants maintained a remarkable output of papers dealing mainly with the constituents of plants. Fellows of the Chemical Society will remember the occasions on which these papers were read, for the lecture table was always decorated with an extensive series of small glass bottles, each containing a specimen of one of the constituents isolated from the plant under discussion. Each bottle was labelled in Power's meticulously careful caligraphy, and the bottles were always arranged in the precise order in which the author would describe their contents. These ranged from simple fatty acids to the most complex of glucosides or alkaloids and all the solids were beautifully crystallised. Power belonged to the generation of chemists who were primarily interested in the isolation of the constituents of plants in a pure state, and his papers devote little or no attention to speculation on the origin of these substances or to their possible bearing on biological relationships, but they form a mine of information, upon which in due course bio-chemists interested in these things will be able to draw.

The work of Power and his collaborators, among whom Mr. Tutin and Mr. Barrowcliffe should be specially mentioned, has already borne fruit in at least one direction, for it is upon the results of their researches on the peculiar acids of chaulmoogra and hydnocarpus oils that the whole of the modern treatment of leprosy is based. Similarly, they did much to extend our knowledge of the distribution of sterols in plants, and in view of the recent discovery of the connexion between certain types of sterols and vitamin D, this work may prove of considerable scientific interest.

In 1914, Power returned to the United States, where he carried on similar work in the phytochemical laboratory of the United States Department of Agriculture. In the previous year he

had been awarded the Hanbury Medal by a joint committee of the Chemical, Linnean, and Pharmaceutical Societies of Great Britain, an award peculiarly fitting for so untiring a pioneer in plant chemistry, and one which he regarded as not the least among the many of which he was the recipient.

DR. JOHN BROWNLEE.

THE unexpected death of Dr. John Brownlee, after an illness of little more than two days, has removed one of the very few highly trained research workers in the field of biological and medical statistics. Dr. Brownlee, who was in his sixtieth year, had been, since 1914, Statistician to the Medical Research Council and Director of the Council's Statistical Department at the National Institute of Medical Research. He was a graduate in arts, science, and medicine of the University of Glasgow, and obtained first-class honours in mathematics and natural philosophy. Before his appointment by the Medical Research Council he had held several important medical posts and successfully directed two large hospitals for infectious diseases.

Brownlee's scientific output was very large; he was the author of more than eighty separate papers. He was particularly interested in the study of periodicity in epidemic disease and, in a series of memoirs, applied the method of periodogram analysis to the data of all the important infectious diseases. Perhaps the most complete of these memoirs was that dealing with measles, which was published in the *Philosophical Transactions of the Royal Society* (Ser. B, vol. 208 and 209, 1917 and 1918). He was also intensely interested in the application to the phenomena of human physiology of physico-chemical laws; his numerous papers on this topic, and the zeal with which he sought to apply physico-chemical equations, led his very numerous friends to rally him on holding that the general law of life was a geometrical progression.

These subjects, however, by no means exhausted Brownlee's energies. Within the medical field his work on the epidemiology of phthisis and various more specialised papers upon infectious disease were important, while his contributions to the study of Scottish anthropology and archaeology are noteworthy. His range of scholarship was extremely wide and his outlook philosophical. Valuable as have been his individual contributions to science, it is regrettable that he never carried out an intention he once formed of preparing a comprehensive treatise which would have given full scope for his powers. Dr. Brownlee has left a gap which it is impossible to fill, for he combined technical knowledge and wide intellectual culture in a way which is unfortunately rare in the younger generation of investigators.

News and Views.

THE Imperial Conference of last year, at which the self-governing Dominions and India were represented, is to be followed by a Conference—the first of its kind—called by the Colonial Office, which will be attended by representatives of the non-self-governing Colonies, Protectorates, and Mandated Territories. Most of these dependencies will be represented by their governors or by a senior official, and officers of the specialised services who are on leave will be invited to be present at discussions of papers and addresses dealing with matters of particular concern to their several departments. The Conference will hold its first meeting on May 10. Its main object will be to secure more effective co-operation between the various Colonial governments in matters of general interest. The items for the agenda are grouped under the headings: (a) Questions of general administration; (b) economic questions covering trade and communications; (c) problems of technical services. In each of the three sections matters of particular interest to scientific and technical workers are down for discussion. Under (a) there should be an interesting interchange of views on “the relation of technical to administrative services,” which is to follow a subject of particular significance to the Colonial services, the recruiting and training of Colonial civil servants. It would be a healthy sign if consideration of this subject were to embrace the principles governing the selection of Colonial governors themselves. Far too many men of high rank in the Navy or Army have been made governors of the dependencies of the Crown as a reward for past services of a character which often unfitted them for the essentially creative work of controlling the destinies of backward peoples.

It is to be hoped that due publicity will be given to the proceedings of this Conference. The papers dealing with such matters as “Recent Developments in Mechanical Transport,” where the results of experiments with various types of trackless mechanical vehicles will be given; the progress and possibilities of “Civil Air Development” as affecting the various territories; and “Wireless Communications,” should contain much information of value to technicians at home who are interested in these matters, apart altogether from their particular interest to home traders and manufacturers. Under “Problems of Technical Services” special emphasis is to be put upon the need and the means whereby to effect co-operation and exchange of information in research and technical matters. This subject, it will be remembered, assumed great importance at the last Imperial Conference. Most of the activities of the specialised services, health, agriculture, forestry, education, are to be dealt with, but it is to be regretted that no specific mention is made of the geological surveys or of the departments of mines. The number of Crown Colonies which maintain such surveys may not be large, but the activities of the existing surveys are sufficiently important to be brought to the notice of the Conference.

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THE new radio beam service to Australia was opened to the public on Friday, April 8. The messages are dispatched in London by the ordinary Wheatstone machines and pass automatically by land line to the sending station at Grimsby. They are then sent by a beam of radio waves on their 10,000-mile journey to the Australian receiving station at Rockbank. Finally they travel by land line into the receiving office at Melbourne. The messages coming from Australia to Great Britain pass from Melbourne to Ballan, a distance of 55 miles; then from Ballan to Skegness, and finally to London by land line. It is interesting to learn that it is possible to direct the beam either eastward over Europe and Asia, or westward over America and the Pacific. In the reverse direction this can also be done from Melbourne. The route is chosen according to the time of day. It is found that radio signals travel better at night, and so the darker of the two paths is chosen. The signals take one-eighteenth of a second to travel from the transmitter on the one continent to the receiver on the other. The speed of transmission is governed only by the limitations of the transmitting and recording instruments used. The Marconi Company contracted to provide a system which would work at the rate of 100 words per minute, in both directions at once, for seven hours a day. The performance largely exceeds the minimum specified. The working has been carried out for 18 hours out of the 24, and for several hours the speed has been at the rate of 200 words a minute. On test also the speed was worked up to 325 words a minute. It is stated that the Indian and South African radio beam links will be ready for tests in a few weeks' time. The Canadian beam link has been working since last October.

MR. H. FRANKFORT's preliminary summary of the results obtained from excavations carried out by the Egypt Exploration Society during the past winter at Tell el-Amarna, which appeared in the *Morning Post* of April 4 and 5, suggests that his report, when published in full, will prove of exceptional interest in the light it will throw on the everyday life of the ordinary individual. One part of the work has been directed to the investigation of a suburb of the city founded by Aken-aten, which was populated, not to say over-populated, by members of the middle and lower classes. It has revealed the plan and domestic economy of private residences ranging in size from the ‘comfortable’ down to the mere hovel. It has been found, for example, that in the larger houses the kitchen was situated at some distance away from the main structure; in the smaller it was erected against the wall of the building, and access to the dining-room was provided by means of an entrance from one of the loggias, which were a characteristic of these residences to secure coolness. Some interesting and instructive examples of bed- and bath-rooms were found in a state of good preservation. In houses even of this size the domestic

apartments were shut off from the public or official reception room, with which they communicated by a corridor. It is interesting to note that notwithstanding the prevalence of the official *aton* or sun-disc worship, as shown by the numerous shrines found in courtyards or by the wayside, the population of this suburb still clung to its belief in the efficacy of amuletic deities, such as Bes, the cow-eared Hathor and Tauret. One of the shrines produced a small red crystalline sandstone head of one of the youngest daughters of Aken-aten. Its peculiar conformation recalls that of the head of her father, and lends further support to the view that this shape was not due to disease, but was congenital and possibly a family characteristic. It was found to occur in the head of Tut-ank-amen when his mummy was unwrapped, and has given rise to the suggestion that he was the son as well as the son-in-law of the Heretic King.

ANOTHER discovery which is of considerable interest in relation to the court life and organisation of early Egypt is announced in the *Times* of April 7. The expedition of the Vienna Academy of Sciences has discovered on its concession near Giza, among sun-brick tombs of the Sixth Dynasty, a quadrangular room roofed with a well-preserved brick dome with corbels. Such domes hitherto were not known before Roman times, but are thus proved to go back so far as 3000 B.C. In a statue room adjoining the false door of the *mastaba* is a closed stone coffin with two slit-shaped openings, in one of which is a very fine group of painted limestone representing the owner, Senab, and his wife and children. Here and in the paintings and inscriptions of a votive offering table, Senab is shown as a dwarf. He was superintendent of the dwarfs in charge of the king's wardrobe, and it is clear from the inscriptions that he was possessed of considerable wealth. It is remarkable, and at the same time significant, that while he is depicted in such a way as to suggest a lowly origin, his wife was a princess. The question of the origin, character, and position of dwarfs at the royal court of Egypt is one of considerable interest. A connexion with pygmy races has been suggested; but in all probability they were pathological. A number of cases of pathological dwarfism have been recorded from Africa.

ALTHOUGH several centenary celebrations are being held this year, bicentenary celebrations are, comparatively speaking, very rare. All such celebrations are by their very nature apt to be ephemeral in their appeal to the public interest, but efforts are being made to mark in some fruitful way and locally the recent bicentenary of Isaac Newton, who received his early schooling at the old King's School at Grantham in Lincolnshire. A scheme has been inaugurated by the Mayor of Grantham to raise a fund to found an Isaac Newton scholarship in natural science and mathematics for the benefit of the boys of Newton's old school. Locally about £1500 has already been raised towards the £5000 or £6000 which is required. Such a scholarship would be a strong

incentive to the boys of his own native place to develop the scientific side of their education, and would surely be a fitting memorial of Newton's great genius. The success of the scheme will ensure that no boy from Newton's own countryside and town, with real scientific talents, will be prevented by lack of means from receiving the benefits of a university education. Donations to the fund should be sent to the Mayor, The Mayor's Parlour, Grantham, Lines.

IN a paper read to the Institution of Electrical Engineers on Mar. 31, W. McClelland, the director of electrical engineering to the Admiralty, discussed the applications of electricity in warships. He pointed out that the Washington Treaty has made naval superiority by means of large warships impossible. There has therefore been intense concentration on improving the efficiency of the unit and on improving its design. The weight and size of every piece of apparatus has to be reduced to the minimum and everything superfluous has to be eliminated. The Treaty has therefore forced on naval designers very exacting problems. He stated that the two new aircraft carriers of the U.S. Navy have a speed of about 35 knots and each develop 180,000 shaft horse power; that is, their output is equal to that of a modern super-power electric station. Electric propulsion of ships has not yet been largely adopted in Great Britain, possibly because at full load the efficiency of turbo-electric transmission is somewhat less than that of the geared turbine. The development of radio communication enables a navy board to keep in touch with fleets dispersed throughout the world. In a battleship there are some 700 telephones, including loud-speaking telephones for use in noisy compartments and for broadcasting. It is interesting to note that in the motor boats of the fleet, electric starting and lighting sets working at 12 volts, and very similar to an ordinary motor-car starting and lighting equipment, are used.

THE first Empire Mining and Metallurgical Congress was inaugurated at Wembley in 1924, when it was decided to arrange for a triennial meeting. The invitation for the second congress came from Canada, where the opening session will be held in Montreal on Aug. 22 next. There will also be sessions in Toronto, Winnipeg, and Vancouver, and the full programme, which includes visits to most of the principal mining centres, metallurgical works, and places of scenic interest, will occupy about six weeks. The Canadian Institute of Mining and Metallurgy is the convening body on this occasion, the other constituent organisations being the Institute of Metals, the Institutions of Mining Engineers, Mining and Metallurgy and Petroleum Technologists, and the Iron and Steel Institute (all of London); the Chemical, Metallurgical and Mining Society of South Africa, the South African Institution of Engineers, the Australian Institute of Mining and Metallurgy, and the Mining and Geological Institute of India. A large attendance is now certain; members are expected from all parts of the Empire, and there will be representatives from nearly every civilised country.

About 300 are going from Great Britain, including more than 100 ladies. The business side of the Congress includes the consideration of papers giving valuable information on the mining and metallurgical conditions in the scattered units of the Empire; there will also be under discussion certain broad problems of Empire policy in relation to metals and minerals. No efforts are being spared by the organisers to make the Congress a most valuable educational opportunity. A magnificent round tour has been arranged from Montreal to Vancouver and back, approximating 7500 miles, and a rather shorter tour has been planned in eastern Canada and Newfoundland. Elaborate arrangements are being made for the comfort and entertainment of the visitors. Communications should be sent to the Secretary-General of the Congress, 225 City Road, E.C.1.

THE first number of a new quarterly review devoted to archaeology made its appearance on Mar. 15. The title is *Antiquity*, and its editor is Mr. O. G. S. Crawford. In his editorial notes Mr. Crawford describes the aim of the new publication, which will be to attempt to summarise and criticise the work of those who are revealing the past. As he rightly says: "Here and there attempts are made to summarise a period or interpret a group of facts; but they seldom reach the general public, and remain buried in obscure publications." The editor has secured the co-operation of a distinguished body of archaeologists, who will contribute first-hand information about their own researches. The field is world-wide and the subjects are of the most varied character. The review will not confine itself too rigidly to the past. "The past often lives on in the present. We cannot see the men who built and defended the hill-top settlements of Wessex; but we can learn much from living people who inhabit similar sites to-day in Algeria."

THE first number of this review abundantly justifies its promise, as a list of the articles and authors will show. We have first an article on "Lyonesse," by the editor; then "The Roman Frontier in Britain," by Mr. R. G. Collingwood; "Orientation," by Admiral Boyle-Somerville; "Stonehenge as an Astronomical Testament," by Mr. A. P. Trotter; "Prehistoric Ways," by Mr. R. C. C. Clay; "Maori Hill-Forts," by Mr. Raymond Firth; "The Danube Thoroughfare," by Prof. V. G. Childe; and last but not least, "Prehistoric Timber Circles," by Mrs. Cunningham. These articles are followed by notes and news and some valuable indications of forthcoming excavations, with nearly twenty pages of reviews of recent publications. If we were to select one article for mention it would be, perhaps, Mrs. Cunningham's on "Prehistoric Timber Circles," in which an authoritative account is given of the excavation of a monument of a type hitherto undiscovered in Great Britain, which, so far as is at present known, has only one parallel—in Holland. The discovery of this circle, called appropriately "Woodhenge," was originally made by Squadron Leader Insall, V.C., whilst flying near Stonehenge on Dec. 12, 1925, but its true nature was not ascertained

by him until flying in July 1926, when the wheat was well over the site. His photographs, taken on the latter occasion, are reproduced and show ring shadows and concentric rings of dots, caused by irregularity in the growth of the wheat, due to the ancient excavations. But *Antiquity* is full of such good things, written in a way to interest the general public as well as those who are more immediately concerned with archaeology. We welcome its appearance, and we congratulate all those connected with its publication. All communications should be addressed to Mr. Crawford, Ordnance Survey Office, Southampton.

THE annual report of the Rockefeller Foundation for 1925 has recently been issued, and the year's work is reviewed by the president, Dr. George E. Vincent. Through its departmental agencies somewhat more than 9,000,000 dollars were expended. The governments of eighteen countries were aided to combat hookworm disease. Rural health services were helped in American States and in Brazil, Poland, Czechoslovakia, Austria, and France. Precautionary measures were instituted against yellow fever in the Central American States and in Brazil, and a yellow-fever commission was sent to West Africa. Contributions were made to the League of Nations' international study tours. Malaria control was demonstrated or aided in American States and in Brazil, Argentina, and Italy. Contributions were made to public health teaching and medical education in a number of cities and countries, including Cambridge, Edinburgh, and Montreal. Nursing education, mental hygiene, and biological research were also assisted. This list by no means exhausts the activities of the Foundation, and 350,000 dollars, to be spread over ten years, have been allocated towards the cost of a journal of biological abstracts on an international basis.

AFTER nearly thirty-five years of activity, during which it has done so much admirable work, the Imperial Earthquake Investigation Committee in Japan has been replaced by a new body, the Earthquake Research Institute, with wider aims. The Investigation Committee, founded shortly after the great Mino-Owari earthquake of 1891, was designed for practical purposes, though the Committee has always given a liberal interpretation to its instructions, and most of its contributions have been in the domain of pure seismology. The new Institute has its headquarters in the Imperial University of Tokyo, and its sole object is to be scientific research, the practical work of the old Committee being continued by the Earthquake Advisory Council in the Department of Public Instructions. The staff of the Institute includes all the leading seismologists of Japan, the director being Prof. K. Suyehiro. The *Bulletin* issued by it is an expansion of that published by the Investigation Committee, though, unfortunately for European readers, all the papers in the first number are written in Japanese instead of in English. They are, however, preceded by very brief summaries either in French or English.

THE Mellon Institute of Industrial Research, University of Pittsburgh, is primarily a technological experiment station, but the need for fundamental scientific research as a background and source of stimulus for research on behalf of industry has always been recognised. During the past five years the Institute has been giving an increasing amount of attention to the encouragement and support of research in pure chemistry, and has been progressively successful in arranging for funds for investigations not suggested by industry, but planned within the Institute for the study of basic problems. Since 1922 Dr. Leonard H. Cretcher has been in charge of the Institute's research in pure chemistry, and has contributed a number of papers to the literature. Hitherto these investigations have been conducted in accordance with the Institute's fellowship system, but the Director, Dr. E. R. Weidlein, has recently announced the establishment of a definite department of research in pure chemistry, with Dr. Cretcher as its head. Dr. Cretcher will supervise all the Institute's purely scientific studies in chemistry, and will also act as an adviser to those holders of industrial fellowships who are carrying on research on specific problems in synthetic organic chemistry. The new department will be operated as an integral part of the Institute and will be sustained by institutional subsidy. Dr. Cretcher will be assisted by Dr. William L. Nelson as fellow in pure chemistry. Dr. Nelson was formerly a member of the staff of the department of chemistry of the University of Pittsburgh.

OPINIONS 91-97 rendered by the International Commission on Zoological Nomenclature have been published by the Smithsonian Institution in its Miscellaneous Collections. To the Official List of stable generic names there have been added, as fulfilling all requirements of the rules, the names of 35 Mammalia, 9 Reptilia, 3 Amphibia, 4 Pisces, 5 Tunicata, 17 Mollusca, and 2 Protozoa. The following 12 names of Pisces, now current, have been added to the same list by suspension of the rules (as *flat* names), with the genotypes as given in parentheses: *Conger* Cuv., 1817 (*Muraena conger* L.); *Coregonus* Linn., 1758 (*Salmo lavaretus* L.); *Electris* Bloch and Schneider, 1801 (*gyrinus* Cuv. and Val.); *Epinephelus* Bloch, 1792 (*marginalis* Bloch); *Gymnothorax* Bloch, 1795 (*reticularis* Bloch); *Malapterurus* Lacépède, 1803 (*Silurus electricus* L.); *Mustelus* Linck, 1790 (*Squalus mustelus* L. [= *Mustelus laevis*]); *Polynemus* Linn., 1758 (*paradiseus* L.); *Sciæna* Linn., 1758 (*umbra* L. = *Cheilodipterus aquila* Lacép. restr. Cuv. 1815); *Serranus* Cuv. (*Perca cabrilla* L.); *Stolephorus* Lacép., 1803 (*commersonianus* Lacép.); *Teuthis* Linn., 1766 (*javus* L.). Conchologists will be delighted or dismayed to learn that the *Museum Boltenianum* (1798) is accepted as nomenclatorially available. With like diversity of feeling entomologists will take note that the "generic" (?) names in Hübner's "Tentamen" (1806) are ruled out—first, as not published; secondly, as *nomina nuda*. At any rate it is good to have these long-controverted questions authoritatively settled.

IN the *Quarterly Review of Biology*, vol. 1, No. 4, Dr. Raymond Pearl publishes an interesting comparison of the prices charged for scientific books, as received in the United States from various countries. The most expensive are books first manufactured and published in Great Britain and then published in the United States by an American branch of the original firm. Next come those published in various unnamed countries, and then the books published in England and directly imported into the United States. It appears that the cost of running a branch in America adds 20 per cent. to the price of an English book; but this includes duty. American books published in the United States are only 12½ per cent. cheaper than books published in England; but German books are 10 per cent. less, and this is rather surprising in view of recent complaints that certain German publishers have been making a corner and forcing up prices. French books, thanks to the failure of their publishers to keep pace with the franc, have averaged little more than a quarter the price of English books. In comparing French and German books with English and American, it should be remembered that the former are generally in paper wrappers and the latter generally cased.

JOHN E. TEEPLE, consulting engineer, New York City, has been awarded the Perkin medal by the American Section of the Society of Chemical Industry for "significant scientific, technical and administrative achievements, particularly the economic development of an American potassium industry at Searles Lake, California." This medal is awarded "annually to the American chemist who has most distinguished himself by his services to applied chemistry," and was founded in 1906 at the time of the fiftieth anniversary of the coal-tar discoveries, the first medal being awarded to Sir William H. Perkin himself.

MR. HUGH C. SAMPSON, formerly Director of Agriculture, Madras, has been appointed economic botanist at the Royal Botanic Gardens, Kew. This appointment has been made possible by a grant of £4000 for five years from the Empire Marketing Board, through the Ministry of Agriculture and Fisheries. The object of the grant is to promote that co-operation of Kew with the Dominions and Colonies which has already proved of great value in the introduction of new staples and the development of natural vegetable resources in new territory. Part of the grant will be available for sending out botanical collecting expeditions. Since his retirement, Mr. Sampson has been engaged in research on cotton and other economic products in Nyasaland under the Empire Cotton Growing Association.

THE fourth International Congress of Theoretical and Applied Limnology is to be held at Rome in September 1927; the exact dates and details of the programme are to be published later. It is proposed to organise limnological excursions around Rome and the regions of central and northern Italy and Naples, while a Limnological Exhibition will be held in Rome and a Fishery Exhibition in Como. Intention to be

present and titles of papers proposed to be presented should be communicated without delay to the Organising Committee of the Congress. R. Laboratorio Centrale di Idrobiologia Via Tiburtina, Roma 38.

A YEAR ago the "Sanitation Supplements" issued with the *Tropical Diseases Bulletin* were discontinued and replaced by a monthly *Bulletin of Hygiene* for the review of the literature of public health and preventive medicine, of which we have received No. 1 of vol. 2, 1927. It contains summaries and reviews of publications on all branches of public health and preventive medicine, and is intended to meet more particularly the needs of Britain overseas. The Bulletin is issued by the Bureau of Hygiene and Tropical Diseases, 23 Endsleigh Gardens, W.C.1, at the subscription price of 21s. per annum.

THE latest catalogue (No. 493) of Mr. F. Edwards, 83A High Street, W.1, is devoted to works relating to Canada and Arctic discovery. Particulars of nearly 600 volumes, maps, drawings, etc., are given. The catalogue is to be had free upon application.

WE have just received from Messrs. Bernard Quaritch, Ltd. (11 Grafton Street, London, W.1), a copy of Catalogue (No. 407) of upwards of 1900 works on zoology, geology, and palaeontology. The list should be of very great interest to librarians and others, seeing that it gives particulars of important publications many of which are of extreme rarity.

Our Astronomical Column.

COMETS.—Comet Comas Sola, 1926*f*, is still well placed in the evening sky. Several observers have noticed a short tail.

The following photographic observation is by F. J. Hargreaves, measured by G. Merton:

U.T.	R.A. 1927-0.	N. Decl.	Mag.
Mar. 23-8729	4 ^h 36 ^m 26-67 ^s	30° 27' 45-5"	12-5

It had a central condensation, 5" in diameter: ephemeris for 0^h:

	R.A.	N. Decl.	log Δ .
Apr. 14.	5 ^h 36 ^m 6 ^s	32° 41'	0-305
22.	5 59 56	33 3	0-319
30.	6 24 6	33 14	0-332

Mr. B. Strömberg has revised the orbit of Stearns's comet, using observations until Mar. 31, and obtains:

T	1927 Mar. 20-2338 U.T.
ω	10° 38' 63
Ω	214 36-67 } 1927-0
i	87 33-38 }
log q	0-56631

It has the fourth largest perihelion distance known.

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.
Apr. 13.	14 ^h 57 ^m 9 ^s	4° 41'
21.	14 49 59	7 42
29.	14 42 20	10 37
May 7.	14 34 31	13 18

THE DETONATING METEOR OF OCT. 2, 1926.—In a reprint from the *Meteorological Magazine* (Dec. 1926 and Jan. 1927), Mr. F. J. Whipple has detailed observations made to investigate the velocity of sound transmission from meteor observations, as it seems possible that the temperature of the air

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An analyst at the Building Research Station of the Department of Scientific and Industrial Research—The Director, Building Research Station, Bucknall's Lane, Garston, nr. Watford (April 25). An advisory officer on farm economics under the Board of Agriculture for Scotland—The Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh (April 30). A bio-chemist at the General Hospital, Birmingham—The House Governor of the Hospital (May 2). An assistant demonstrator in physics (woman) at the Royal Holloway College—The Principal, Royal Holloway College, Englefield Green, Surrey (May 7). A laboratory assistant in connexion with the Imperial Bureau of Entomology, for work relating to living insects—The Assistant Director of the Bureau, 41 Queen's Gate, S.W.7. A laboratory attendant in histology at University College—Prof. J. P. Hill, University College, Gower Street, W.C.1. A woman lecturer in geography and science at the Truro Diocesan Training College—The Principal. A lecturer in geography at St. Mary's Training College, Strawberry Hill, Middlesex—The Principal. A male laboratory assistant for a biochemical laboratory—The Wellcome Physiological Research Laboratories, Beckenham. A professor of agriculture, and lecturer in dairy bacteriology, dairy technology, dairy chemistry, dairy engineering, and dairy accountancy and economics at the University College, Cork—The Secretary.

may materially affect the rate of motion of sound waves.

The great Yorkshire meteor of Sept. 6, 1926, which gave a loud detonation, promised an opportunity for such inquiries, but unfortunately the observations were not of desirable accuracy.

Another fireball appeared on Oct. 2 moving up from south to north over the Channel, west of London, and on to Hertford. An appeal for data was made through the medium of the Air Ministry, and 700 responses were received at the Kew Observatory.

The evidence from the Yorkshire meteor convinced Mr. Whipple that the thunder-like noise was produced by the mere passage of the meteor through the air. The sharp detonation of the meteor of Oct. 2 had a similar origin. Mr. Whipple remarks that Dr. Wegener had previously formed these conclusions from his study of the fireball of April 3, 1916. "Wegener points out the analogy with the noise produced by the passage of a shell fired from a big gun. It is well known that a projectile moving through the air with a velocity exceeding that of sound makes a wave like the bow-wave from a ship. This wave when it reaches an observer is heard as a sharp crack. The crack is followed by a rumbling noise which may be attributed to the irregularities in the aerial disturbance. The nature of these ballistic waves is expounded at length in a recent work by Prof. Ernest Esclangon, the pioneer of sound-ranging."

"As the meteor of Oct. 2 was moving about 70 times as fast as sound, the ballistic wave must have taken the form of a very sharp cone, nearly a cylinder. That sound was not heard beyond the end of the meteor's track may be analogous to the fact that the ballistic wave from a shell is not heard behind the gun."

Research Items.

NIUE (SAVAGE ISLAND).—As the result of seven months' field work in Niue, Mr. Edwin M. Loeb has collected evidence relating to the ancient customs, history, and traditions of the island which has been published as Bulletin 32 of the Bernice P. Bishop Museum, Honolulu. The population of Niue has been decreasing steadily since early missionary days, but the decline is now said to have run its course. During the year 1922 the deaths were 21.69 per thousand; the births 26.18. One of the prominent features of its culture is the division of the island into endogamous hostile moieties—a division which it is fairly safe to conclude is due to separate migrations. Historical traditions record three such migrations; minor differences of language, mythology, and physique still appear between the two ends of the island, and these were probably much greater in prehistoric times. The most important piece of evidence, however, is the difference in physique between the inhabitants of Motu and Tafiiti. The people are undoubtedly of Polynesian stock. They lived under very primitive conditions, i.e. their political and social organisation was far less highly differentiated than that of other Polynesian peoples. Not only was a well-developed system of government lacking; but also the people themselves were not grouped according to crafts and occupations. There was no actual priestly class, and to the lack of power in the priestly class may be due the absence of the attribution of divinity to the ruling classes, of the taboo on women, and of the caste system imposed on the common people—features of Polynesian culture which developed at a relatively late date. There is also a lack of lengthy genealogies and of a well-developed stock of mythologies. Probably Niue was settled at an early date and, owing to its isolation, preserved its primitive institutions long after its neighbours had been converted to theocratic rule. It perhaps represents an archaic type of social organisation once common to all Polynesian peoples.

MIDDLE AMERICAN ARCHAEOLOGICAL RESEARCH.—In Year Book No. 25 of the Carnegie Institution of Washington, which covers the year 1925–26, Dr. Sylvanus G. Morley reports on the work of archaeological exploration in Central America which is being carried on under the Institution. This is becoming of increasing importance as the excavation and preservation of the Maya site of Chichen Itza progresses. This work is fully described by Dr. Morley and Mr. E. H. Morris in dealing with the Temple of the Warriors and the North-west Colonnade. Among a further number of noteworthy examples of Maya art, special mention is made of examples of painting in which the colours, having been shielded from light and air, have been preserved in a remarkable manner. These, with others which have come to light, serve to show the importance of colour rather than of relief in these examples of Maya artistic technique. Important as this work is, it is overshadowed by the interest of the expedition of the Institution to Coba and also to Chetumal Bay in Yucatan, where the date inscription discovered by Dr. T. W. Gann, and giving the date A.D. 333, was examined. At Coba, the discovery of the site Macanxoc with eight Initial Series on May 24 constitutes one of the most important contributions to Central American archaeology of the last five years. It practically trebles the Initial Series known from the Peninsula of Yucatan, and promises to throw a flood of light on the early history of the country. The dates of these series run in ten-year periods from A.D. 354 to A.D. 413. Two other monuments of which the inscriptions are illegible probably completed the

sequence. The significance of Macanxoc lies in the fact that the latest date antedates the earliest date at Chichen Itza by more than two centuries, and pushes back the discovery of Yucatan a century earlier than the date for that event given in the Books of Chilan Balam.

FRESHWATER EELS IN JAVA.—An interesting addition to our knowledge of the distribution of freshwater eels has been made by Dr. H. C. Delsman in Java (*Treubia*, vol. 9. 4; 1926, and *De Tropische Natuur*, No. 10; 1926). The work was undertaken in response to a suggestion of Dr. Johs. Schmidt in his recent survey of the freshwater eels of the Indo-Pacific Region, that if zoologists in Java would study the distribution there, much light would be thrown on the problem. In the Indo-Malayan area, i.e. the shallow sea surrounded by the Malay Peninsula, Cochin China, and the islands of Sumatra, Borneo, and Java, Dr. Schmidt noted the scarcity or absence of these eels, whereas they were abundant all round this region. He assumed that the larvae of the Pacific species of *Anguilla* are inferior in migratory power to the Atlantic species and that they are unable to migrate through shallow water, and so are only found in numbers on the coasts facing deep water. Dr. Delsman's investigations resulted in a complete confirmation of Dr. Schmidt's conclusions. He found two species of freshwater eel common in Java, the mottled *Anguilla mauritiana* and the smooth *A. bicolor*, called 'dog-eel' by the natives and considered by them 'unclean' for food. They were present in all the rivers of the south coast and on the east and west as well, but were absent from the rivers of by far the largest part of the north coast. The suggestion is made that the development of the tropical species is accelerated by the higher temperature, so that the distance covered by the larvae during their migration must be shorter than in the cooler seas. An excellent map of Java is given showing the extent and results of the survey.

THE INSECT FAUNA OF THE LESSER-KNOWN HAWAIIAN ISLANDS.—Changes in the fauna of the Hawaiian Islands through the demolition of native forests and the extension of cultivation have resulted in the extermination of certain of the endemic insects. At the same time, the maritime importance of Honolulu as 'the cross roads' of the Pacific has facilitated the entry through commerce of many alien species. In view of this process of subtraction and addition that is still altering the indigenous fauna to-day, the foresight of those Englishmen who inaugurated the "Fauna Hawaiiensis," and saw it through to completion, becomes increasingly evident. This work is the scientific basis for all subsequent progress in Hawaiian entomology but, at the time of its completion, the fauna of certain of the small outlying islets, north-west of the Island of Kauai, was little known. In 1923 the *Tanager* expedition made a biological survey of these remote areas and also of the still more distant Johnston and Wake Islands. A report on the insects by Mr. E. H. Bryan, jun., and collaborators, has recently appeared as Bulletin 31 of the Bernice P. Bishop Museum, Honolulu (1926). Many of these islets betray evidences of the landing of man thereon, in the occurrence of cosmopolitan insects. Perhaps the most unexpected record is the presence of the Diamond back moth (*Plutella maculipennis*) on most of the areas surveyed, including the remote Wake Island. The establishment of a cable station on Sand Island explains the presence of certain insects un-

doubtedly introduced from Honolulu. Of the two truly indigenous butterflies found in the larger Hawaiian Islands, *Lyceena batia* occurs only on Necker Island among the islets fringing the archipelago, while the migrant *Hypolimnras bolina* was only met with on Wake Island. Among the new species described in this bulletin, nine are parasitic Hymenoptera, sixteen are Coleoptera, and five are Lepidoptera.

A NEW SPECIES OF PARAGONIMUS.—A. Gulati (*Mem. Dept. Agr. India, Veterinary Series*, vol. 3, No. 8, 1926) describes a new species of *Paragonimus* (*P. edwardsi*) from the lung of a palm civet (*Paradozurus graji*). Eight cysts were found in the lungs and in each were two flukes, the principal organs of which are described, but the accompanying illustrations are somewhat crude.

STUDIES ON SANGUINICOLA.—Dr. L. Ejsmont describes (*Bull. Acad. Polon. Sci. et Lettres*, Ser. B, 1925, pp. 877-966 + 4 pls.) the structure and development of three species of the trematode *Sanguinicola*. The majority of the worms were obtained from the heart and bulbus arteriosus of tench and carp (*Cyprinus carpio* and *Carassius carassius*). The largest number of worms (which are usually 0.6 mm. to 1 mm. long) found in any one heart was thirty. The distinctive characters of the genus and of the three species are given in detail. *S. armata* occurs only in tench; *S. inermis* was found exclusively in *Cyprinus carpio*, and *S. intermedia* n.sp. in *Carassius*. The author has found sporocysts and two species of cercariae of *Sanguinicola* in *Limnaea stagnalis* and *Bithynia leachi*, and suggests that the smaller cercaria from *Limnaea* belongs to *Sanguinicola intermedia*, and the larger one from *Bithynia* to *S. armata*. A table is given showing the characters of other blood-inhabiting trematodes.

PRESERVATION OF WILD NATURE IN CRIMEA.—The flora and fauna of the Crimea are of special interest since these include a large number of typically Mediterranean elements and a considerable percentage of truly endemic forms. With the view of preserving natural conditions in their virgin state, a national reservation was recently formed stretching over 23,000 hectares (*Priroda*, No. 2, 1927), and comprising uplands rising to 1500 metres, covered with forests of Crimean beech (*Fagus taurica*) and oaks (three species). Amongst other interesting plants are large juniper trees (*Juniperus foetidissima*), some of which are 500 years old; trees of *Taxus baccata*, which species is dying out in Crimea; and white birch, which occurs here only in single specimens, as a relict of a colder age. Mammals occurring in the preserved area include the local race of deer, an endemic species of marten (*Martes rosanovi*), and others, while birds are also represented by local species and races. Since 1925 a biological and a meteorological station have been organised; the latter is specially engaged in a study of the importance of mountain forests for condensation and preservation of moisture, this being a very important economic problem in the Crimea, where deforestation of mountains resulted, as in many other countries, in diminution of the mountain streams necessary for irrigation of lower-lying parts of the country. In 1926 a small local museum was established.

POISONOUS PLANTS OF SOUTH AFRICA.—The problem of stock-raising in a comparatively new country is often complicated by the rôle played by the poisonous plants of the region, and it takes many years of the trial and error method before the poisonous forms can be definitely separated from the harmless species. In this connexion the Botanical Survey of South Africa has performed a useful service to the agri-

cultural community in publishing Memoir 9, "A Preliminary List of the Known Poisonous Plants Found in S. Africa." The knowledge incorporated in this work is mainly due to the researches carried out by the Division of Veterinary Education and Research, and while the information is yet incomplete, sufficient data have been collected to warrant a botanical description of such species as have been definitely proved poisonous. The fifty-one species of plants included have been shown by experimental feeding tests to be injurious to stock, or by chemical analyses to contain poisonous substances. A brief description of each plant is given, and a key to the genera facilitates identification of the various forms, which are illustrated by twenty coloured plates. In addition, notes on the symptoms and diseases produced are appended for each species.

ELECTRIC CURRENTS AND PLANT TISSUES.—Prof. H. H. Dixon and T. A. Bennet-Clark have investigated the responses of plant tissues to electric currents for the purpose of establishing some quantitative relation between stimulus and response, and their results shed some light on the mechanism of control of permeability (*Scientific Proceedings of Royal Dublin Society*, vol. 18 (N.S.), No. 29, Feb. 1927). By observing the response in the actual stimulated cells themselves, the uncertainties connected with the propagation of the stimulus, and the conversion of the propagated stimulus into response, are eliminated. The authors find that the passage of an electrical current through a tissue leads to a change in the electrical resistance and the permeability of the tissue. Pieces of *Hedera helix* cut 1 cm. square were used. A moderate stimulus (120 volts for 0.1 sec.) is immediately followed by a very rapid fall in resistance, the rate of which becomes less rapid. After a few slight undulations, recovery takes place in about an hour, and resistance becomes the same as before stimulation. It is found that response to a stimulus does not develop instantaneously, and maximum change in permeability is only attained 5 min.-10 min. after stimulation. This seems to indicate that the change cannot be entirely due to concentration of ions in the vicinity of the membrane, and it seems probable that the change in concentration of ions produced by stimulation initiates a secondary colloidal change, taking time to reach its maximum and affecting the structure of the semi-permeable membrane. It is supposed that the ability of a current to stimulate a cell is determined by the potential difference across the membrane of the cell.

REVERSAL OF MAGNETIC DIP IN GEOLOGICAL TIME.—Perhaps the most interesting feature of the December issue of *Terrestrial Magnetism and Atmospheric Electricity* is a letter by P. L. Mercanton on a possible inversion of magnetic dip in the course of geological ages. Volcanic lavas in cooling are found to take up a feeble degree of magnetisation, which is very stable and is along the direction and proportional to the intensity of the magnetic field at the point; this occurs after the lava has ceased to be capable of much change of form, and therefore the direction of magnetisation as now observed indicates the direction of the earth's field at the time of setting of the lava, except for any later tilting of the whole lava layer. It is found that the magnetisation of lava specimens is unaffected by considerable artificial impacts. In view of these facts, it is of extreme interest that specimens of lava from Spitsbergen, Greenland, and Jan Mayen indicated almost without exception a magnetic dip of sign contrary to that now existing in Arctic regions. The lava was of tertiary epoch.

More recently, specimens have been obtained, through Sir Edgeworth David and others, of lava from Queensland and New South Wales; they also appear to show a reversal of magnetic dip in the southern hemisphere in permocarboniferous times. These results are so astonishing and of such great significance for any theory of the origin of the earth's magnetic field that it is to be hoped that they will impel other investigators to make similar measurements on specimens from other parts of the globe.

COALFIELDS OF WALES.—The National Museum of Wales has published a pamphlet by Dr. F. J. North: "Coal and the Coalfields in Wales" (Cardiff: National Museum of Wales; London: Oxford University Press; 1s.) in order to make the Museum exhibits relating to the coalfields of Wales more readily intelligible. The work consists of a description of coal and its constitution, of the manner in which coal is produced, and of the general geological condition under which it was deposited. There is also a brief description of the animal and vegetable life of the Coal Measure period. The South Wales coalfield and the coalfields of North Wales are each described in some detail, the useful mineral products other than coal which are obtainable from the rocks of the Carboniferous period are briefly discussed, and the work terminates with a bibliography in which all the works referred to in the present publication are catalogued. The little work is written in a simple and straightforward style, and should answer quite satisfactorily its purpose of giving a clear idea of the origin and nature of coal to the general reader. It has been carefully done, and few errors have been noted.

ELECTRON SCATTERING IN HELIUM.—The March number of the *Physical Review* contains a full account of Dr. E. G. Dymond's work on the scattering of electrons by helium atoms. A preliminary account of these difficult experiments was given in *NATURE* a short while ago (Sept. 4, 1926, p. 336). Differential pumping has to be utilised to maintain a very low pressure in the analysing chamber, and yet have the necessarily higher pressure of about 0.05 mm. in the attached collision chamber. In the latter, the magnetic field of the analysing coils has to be neutralised by means of an auxiliary solenoid, whilst the electron currents are so small that it is frequently necessary to use a Compton electrometer with a sensitivity of 25,000 mm. per volt in order to measure them. The principal loss of energy for the slower electrons is due to excitation of the 2^1S state (20.5 volts); for faster incident pencils there is an increasingly larger number of electrons which suffer retardation over a continuous range between 22 volts and several hundred volts. The angular distribution curve of electrons which have lost energy equivalent to 20.5 volts is a rosette pattern with a number of maxima, the main one being in the forward direction. As is pointed out by Dr. Dymond, the complete investigation will take a considerable time, because of the presence of three variables, the initial velocity of the electrons, their velocity after collision, and the angle of scattering. The field which has been opened up is, however, very wide, and future results may be expected to have an important bearing on the development of atomic theory.

THE PROPAGATION OF FLAME.—The observations of Mason and Wheeler on the propagation of flame in inflammable gas mixtures have raised the question as to whether the conduction of heat is one of the factors which determine flame speeds. A comparison of the speeds of flame in mixtures of different thermal conductivity should test the mechanism of flame

propagation. For this reason H. F. Coward and G. W. Jones have determined the speed of uniform movement of flame in mixtures of methane with air, and with artificial atmospheres of oxygen with argon or helium. The results are reported in the *Journal of the American Chemical Society* (Feb. 1927), and they show that the transference of energy, whether by conduction or radiation, is so rapid that little change in the flame speed is observed. It is evident that the most important factors are the amount of heat developed, the heat capacities of the constituents, and the rate of reaction.

FATIGUE OF METALS IN THE PRESENCE OF CHEMICALS.—Reports and Memoranda No. 1054 of the Aeronautical Research Committee (London: H.M.S.O. 1s. net), by G. D. Lehmann, discusses "The Variation in the Fatigue Strength of Metals when tested in the Presence of Different Liquids." Some work has previously been done on similar lines by Haigh, J. A. Jones, G. Slater, S. C. Langdon, and others. The present experiments concern researches carried out in the engineering laboratories at Oxford on the suggestion of the Elasticity and Fatigue Sub-Committee of the Aeronautical Research Committee. The most unusual result found is the increase of the fatigue limit by 6 per cent. when the steel was tested in the presence of common salt. Wöhler fatigue tests have been made on standard steels in the presence of hot aqueous solutions of sodium nitrate, in sodium or ammonium chloride, in water, after the steel had been pickled in sulphuric acid, and in oil. Control tests were made in hot water and in air at the atmospheric temperature. The results show that oil has no effect, while ammonium chloride reduced the fatigue strength 16 per cent., and sodium chloride raised it by 6 per cent. Sodium nitrate produced no effect on a steel with 0.33 per cent. carbon, but lowered the fatigue limit of 0.13 per cent. carbon steel by 4 per cent. Pickling reduced the fatigue strength by about 8 per cent.

ACTIVITY COEFFICIENTS OF ELECTROLYTES.—The *Journal of the American Chemical Society* (Feb. 1927) contains two interesting papers on the activity coefficients of electrolytes determined by the solubility method. The first paper, by V. K. La Mer, C. V. King, and C. F. Mason, describes measurements made to test the validity of the Debye-Hückel limiting law when applied to salts of high symmetric valence type. Luteo-cobaltamine ferricyanide is a very suitable salt for this purpose, and its solubility was determined in solutions of potassium nitrate, magnesium sulphate, and sodium chloride. The results obtained for the first two solutions are in excellent agreement with the law, but with sodium chloride there are noticeable discrepancies. Nevertheless, the data are interpreted as substantiating the limiting law, at least in its broader aspects. The second paper, by La Mer and Mason, concerns the activity coefficients of salts of high unsymmetric valence type, in this case two cobaltamine salts with the luteo ion as cation. The limiting law was confirmed for a number of solvent salts containing univalent anions, but with solvent salts having anions of higher valency, marked discrepancies were noticed. It is believed that these deviations are due to the fact that the higher terms in the Debye-Hückel expression for the density of electricity have been neglected, factors which become most pronounced for solutions of this type. Qualitative agreement is obtained when these terms are taken into account, and further experiments are in progress to test the truth of the modified principles when applied to examples in which the present form of theory fails.

James Hutton: Father of Modern Geology, 1726-1797.¹

JAMES HUTTON has been justly claimed by Sir Archibald Geikie as the 'father of modern geology.' He was born and bred in Edinburgh, where his father had held the post of City Treasurer. From the High School he went to the University. A chance reference to the potency of *aqua regia*, introduced by way of illustration in a lecture on logic, turned his young fancy to thoughts of chemistry. He followed up the subject in a lexicon; and, when presently apprenticed to a lawyer, he spent his time in making chemical experiments rather than in copying papers. "With much good sense and kindness," Playfair naively remarks, his employer "released him from his obligations." Medicine now seemed the only refuge. Hutton studied in Edinburgh, Paris, and Leyden, where he graduated; but he never practised. His chemical experiments, wonderful to relate, found commercial application; and, with an income in prospect, he turned to agriculture. For experience he went to Norfolk, and it was in England that he first developed an interest in geology.

It is impossible to follow Hutton in detail as Berwickshire farmer and Edinburgh man of science. He travelled considerably, he experimented, he read, and he conversed. He inspired enthusiasm in his circle; and it is mainly through his friends, and after his death, that he exercised an influence upon the course of geology. Playfair's "Illustrations of the Huttonian Theory of the Earth" appeared in 1802 and supplied the foundations upon which Lyell in 1830 reared his "Principles of Geology." Hutton himself was one of those great men who write badly. His "Theory of the Earth," whether we turn to it in the first volume of the *Transactions of the Edinburgh Royal Society*, or in its later expanded book form, is almost unreadable.

Hutton made his mistakes, and in his more important discoveries he was sometimes in part anticipated. This much must be taken almost for granted in presenting a brief account of his achievements. There is, however, one failing that must be mentioned for fear that readers, discovering it for themselves, may be unduly alarmed. Hutton continually explains geological phenomena on the basis of design—"the purpose of this earth," he assures us, "is evidently to maintain vegetable and animal life." Most readers will consider this mode of expression unscientific; but they must always remember that Hutton has righted himself, not only in practice, but also in words. "In the use of means," he explains, "we are not to prescribe to Nature those alone which we think suitable for the purpose, in our narrow view. It is our business to learn of Nature (that is by observation) the ways and means which in her wisdom are adopted."

Hutton's comprehensive contribution to geology is that the past should be, so far as possible, interpreted in the light of the present. His individual discoveries may be enumerated under five headings as follows:

(1) IGNEOUS ROCKS.—Hutton recognised basalt, porphyry, and granite as igneous rocks. The ideas which led him to look for igneous rocks are open to criticism; but the criteria of character and behaviour which he adopted for distinguishing these rocks from sediments have proved trustworthy in most of their applications. Verification of scientific prophecy is always pleasant. Hutton foretold the intrusive relations of granite from inspection of its unstratified crystalline appearance. He confirmed his expectations by visiting Glen Tilt and Arran.

Without going into detail we may recall that Hutton would not admit that any of the Scottish.

igneous rocks had reached the surface; all were, for him, "subterraneous lavas." The credit of recognising ancient surface lavas belongs to Hutton's contemporaries, Arduino and Desmarest, working in recently extinct volcanic tracts of southern Europe.

(2) ELEVATION.—Hutton claimed that the ancient consolidated sediments now so widely exposed to view have been elevated. Most other geologists had withdrawn the sea, instead of elevating the sediments. Hutton, however, emphasised the folded and fractured nature of the upheaved sediments. He also looked for, and found, *unconformities*, which proved to his satisfaction that cycles of elevation and erosion are followed by cycles of depression and sedimentation.

(3) EROSION.—Hutton's conception of the connexion of landscape with commonplace erosion is strikingly modern in its more essential features. It is true that in this great matter he was anticipated by Desmarest—so far as publication is concerned; but there can be no question of the originality of his views, and of the influence they had upon the development of science. "From the top of the decaying pyramids to the sea," he says, in summarising his arguments, "throughout the whole of this long course, we may see some part of the mountain moving some part of the way. What more can we wish? Nothing but time."

(4) GEOLOGICAL TIME.—Hutton realised to the full the immensity of geological time. He had satisfied himself that the various processes of erosion are observable realities, and that they stand in causal relationship to the details of landscape. He was undeterred by the fact that Roman roads can still be traced across the hills of Britain, and that one of their sea-baths cut into the rocks of the Mediterranean shore remains unspoilt. His deduction is confident. The antiquity of history is but the yesterday of geology. In geology itself he saw "no vestige of a beginning—no prospect of an end."

(5) GLACIERS.—Although Hutton was often puzzled by the transport of boulders in his native land, he did not conjure up Scottish glaciers to do the work. On the other hand, he did propose a former vast extension of existent Swiss glaciers to account for the distribution of Mont Blanc boulders which de Saussure had ascribed to deluges. "Let us now consider," he says, "the height of the Alps, in general, to have been much greater than it is at present; and this is a supposition of which we have no reason to suspect the fallacy, for the wasted summits of those mountains attest its truth. There would then have been immense valleys of ice sliding down in all directions towards the lower country, and carrying large blocks of granite to a great distance, where they would be variously deposited, and many of them remain an object of admiration to after ages, conjecturing from whence or how they came."

After perusing Hutton's "Theory of the Earth," the reader may well inquire whether there is any fundamental geological conception to which the author has not contributed. There is one. Hutton used fossils as an indication of ancient conditions of deposit and as evidence of upheaval. He did not recognise the succession of life which they record. Scottish fossils are not as a rule so unlike modern forms as are the ammonites of England. It was natural for Newton's contemporary Hooke (1635-1703) to surmise on the extinction of ancient organisms; and for Hutton's contemporary, William Smith (1769-1839), to establish that "strata" can be "identified by their organised fossils." No Scottish geologist need grudge these laurels to the Southerner.

¹ From the bicentenary address, delivered on Feb. 16 by E. B. Bailey, to the Edinburgh Geological Society.

The Morphology of Filterable Viruses.

THREE brief papers in the December number of the *Journal of the Royal Microscopical Society* by J. E. Barnard, J. Smiles, and F. V. Welch, discuss the great difficulties of determining the outward forms of the filterable viruses, and some contribution is made towards improved methods of attack. Mr. Barnard states that all ordinary bacteria may be stained and their size and form demonstrated if they are not less than 0.2μ in diameter. The virus of bovine pleuropneumonia, which can be definitely and readily grown in artificial media, comes within this limit, but its minute size has precluded any satisfactory knowledge of its real appearance and of any possible phases through which it may pass in its growth cycle. Staining processes, moreover, have not helped matters.

Mr. Smiles has, by the aid of a dark-ground illuminator and an unstopped oil-immersion objective of 2 mm. focal length and 120 N.A., attempted to follow the changes in shape which occur in the virus bodies growing in fluid medium. Drawings of the observed changes are given, and it would appear that, in young culture, grouping of the organism is the chief feature. These groups consist of spherical, aspherical, and granular forms with occasional elliptical and cylindrical masses. These may be so closely apposed to each other as to render difficult the definition of connecting links. Short connecting filaments of low visibility have, however, been detected. As the culture ages, the number of organisms per group diminishes, and finally the culture shows merely single spheres, some with attached granules and some without, and also free granules. Mr. Smiles suggests that in growth the initial spherical form elongates to form the cylindrical type, and this latter breaks up again into two or three small spherical or granular forms. After 48 hours' incubation the cylindrical form may again break up into a chain of four or five granules which finally assume spherical form.

In the course of his work Mr. Smiles has also made use of pleuro-pneumonia cultures grown on thin films of media on ordinary microscopic slips as described by Mr. F. V. Welch. The method employed by him is eminently suitable for the object in view. It should not, however, be described as a new method, but only as one of many modifications of an old and extremely useful method for studying cultural growth *in situ* both in the fresh and in the fixed and stained condition.

University and Educational Intelligence.

THE annual conference of the Association of Teachers in Technical Institutions will be held this year at Plymouth on Friday, June 3—Tuesday, June 7. The provisional programme includes, in addition to the business of the Conference, a number of excursions. Arrangements are being made to visit, amongst other places, the Seale Hayne Agricultural College and the Marine Biological Laboratory, Plymouth. An important feature will be an educational and industrial exhibition in the Guildhall on June 4–10.

APPLICATIONS are invited for the Astley Cooper Studentship at Guy's Hospital, value £150 per annum, plus an additional sum of £50 for expenses. The studentship is tenable for three years. By the terms of the will of the founder, the studentship may not be awarded to any member of the staff of Guy's or St. Thomas's Hospitals, or to any one related by blood or affinity to them. Particulars may be obtained from Mr. C. H. Fagge, Guy's Hospital, S.E.1.

The latest date for the receipt of applications for the studentship is May 31.

THE Charles Lathrop Pack Forestry Trust, founded by Mr. Charles Lathrop Pack, president of the American Tree Association, has given 130,000 dollars for the endowment of a research professorship in forest soils in Cornell University. Generous provision has also been made for the expenses of the advanced investigations to be undertaken, which will be done in the New York State College of Agriculture. The proposed work is a new development in forest research in the United States. Mr. Pack has made other large gifts for the promotion and support of education in forestry. Recently announcement was made concerning the Charles Lathrop Pack Demonstration Forest, 2500 acres of white-pine land on the main Adirondack highway near Lake George; and he has given land or endowments to other American forestry schools, including the New York State College of Forestry, the Yale Forest School, and the University of Washington.

THE fifth Pan-American Child Congress is to be held at Havana in Cuba with the official support of the Government. Owing to difficulties arising from the hurricane the date has been postponed until December 1927. An international exhibition on child hygiene will be held in connexion with the meeting. The Congress will be divided into six sections, dealing with medicine, hygiene, sociology, education, psychology and legislation, and the languages admitted will be Spanish, English, Portuguese, and French. There will be two governmental sessions, for official delegates only; at these, resolutions prepared by the committee will be put to the vote. A draft programme has been prepared with twelve leading topics for each section. As compared with other educational conferences it is interesting to note the great stress on the medical aspects of our problems. The Secretary-General is Dr. Felix Hurtado, Circulo Medico (Malecon 15), Habana. Some information in English typescript has also been circulated by the Commissioner of Education, United States Department of the Interior, Bureau of Education, Washington.

AFTER an experimental period of five years, a record of which is given in the Report of the Central Scholarships Committee of the Ministry of Agriculture and Fisheries (London: H.M.S.O.), the Government has decided to continue the awards of scholarships for the sons and daughters of agricultural workers under a slightly modified scheme. Junior scholarships are provided for short courses in agriculture, horticulture, dairying or poultry-keeping at farm institutes, while senior scholarships are intended for diploma or degree courses in agricultural, veterinary, or allied sciences at universities or appropriate colleges. The senior grade is normally reached after passing through the junior grade, but certain exceptions may be made. All scholarships will allow of attendance at the courses free of cost to the parents. Candidates must be either *bona fide* workers in agriculture or sons or daughters of agricultural or rural workmen, or of working bailiffs and smallholders whose means are comparable with those of agricultural workmen. Provided that a sufficient number of suitable applications are received, about one hundred and twenty junior, ten extended junior, and ten senior scholarships will be awarded this year. Forms of application, to be returned before April 30, and full particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, or locally from the offices of County Councils.

Calendar of Discovery and Invention.

April 17, 1823.—Though Dalton in 1801 had remarked, "There can scarcely be a doubt entertained respecting the reducibility of all elastic fluids of whatever kind into liquids, and we ought not to despair of effecting it in low temperatures and by strong pressures exerted on the unmixed gases," it was not until 1823 that the question was submitted to systematic experiment. Faraday then first obtained liquid chloride and afterwards liquid carbonic acid, ammonia, etc. The details of this work were given to the Royal Society by Faraday in two papers dated Mar. 13 and April 10, and on April 17, Davy in another paper suggested the employment of some of these substances as mechanical agents.

April 17, 1891.—Mechanical traction on common roads long met with opposition from the authorities, and it was an important gain when on April 17, 1891, Leon Serpollet received authorisation to place his steam cars on the streets of Paris.

April 19, 1758.—On this day John Dollond obtained a patent for his achromatic telescope, and that same year he received the Copley Medal "for his curious experiments and discoveries concerning the different refrangibility of the rays of light," communicated to the Royal Society.

April 21, 1686.—As is well known, the publication of Newton's "Principia" was mainly due to Halley. On April 21, 1686, Halley read "A Discourse concerning Gravity" to the Royal Society as preparation for the "incomparable treatise of motion almost ready for the press"; six days later, Dr. Vincent presented to the Society the manuscript of the first book of the "Principia," and on May 19 the Society resolved that "Mr. Newton's Philosophiæ Naturalis Principia Mathematica be printed forthwith in quarto, in a fair letter."

April 21, 1783.—One of the great scientific controversies of the eighteenth century concerned the discovery of the composition of water. The experiments of Cavendish were described in a paper in January 1784, but Watt, so early as April 21, 1783, had written to Black, "In the deflagration of inflammable and dephlogisticated airs, the airs unite with violence—become red hot,—and on cooling totally disappear. The only fixed matter which remains is water, and water, light, and heat are all the products. Are we not then authorised to conclude that water is composed of dephlogisticated and inflammable air?"

April 22, 1663.—The first Charter of Incorporation of the Royal Society was granted in 1661, but it having been found that this failed to give the Society certain privileges essential to its welfare, a second charter was obtained, the patent for which was dated April 22, 1663.

April 23, 1868.—In a paper read to the Royal Society on April 23, 1868, Huggins described the first successful investigation of the motion of the stars in the line of sight by the application of Doppler's principle, announced in 1842.

April 23, 1884.—It is estimated that the development of the steam turbine has halved the cost of the generation of electricity. Though there had been many earlier inventions, no advance was made until 1884, when de Laval and Sir Charles Parsons secured their patents. The patents of Parsons, Nos. 6734 and 6735, taken out on April 23, 1884, were for "improvements in electric generators and in working them by fluid pressure" and for "improvements in rotary motors actuated by elastic fluid pressure, and applicable also as pumps."

E. C. S.

Societies and Academies.

LONDON.

Institute of Metals (Annual General Meeting), Mar. 9.—D. Hanson and Grace W. Ford: Investigation of the effects of impurities on copper. Pt. v.—The effect of bismuth on copper. Experiments on copper containing up to 0.1 per cent. of bismuth confirm the great embrittling effect of bismuth, and indicate that when more than a trace of bismuth alone is present in copper, the working properties, particularly the cold-working properties, are seriously affected. The solid solubility of bismuth in copper has also been investigated.—Clement Blazey: Brittleness in arsenical copper. A description is given of a type of brittleness in arsenical copper tubing developed by annealing in the temperature range 450° to about 650° C. The susceptibility to brittleness was inherent in the 'as cast' billets from which the tubes were made, and no alteration in hot and cold working methods could eliminate it. The degree of susceptibility varied from billet to billet, but the variation could not be connected with chemical composition. After remelting, no trace of brittleness could be developed. Over a period of several years the brittleness was encountered in a certain mill on three occasions, and appeared to be connected with the composition of the refinery charges and with melting operations.

Mar. 10.—R. Genders: The penetration of mild steel by brazing solder and other metals. The cracking of mild steel under slight stress when heated and wetted with brazing solder is due to rapid intercrystalline penetration of the steel by the brass. Copper behaves similarly to brass, but zinc, tin, and lead-tin solder have no perceptible action. The phenomenon of intercrystalline penetration is in many cases of a complex character, involving a third factor.—H. J. Miller: The penetration of brass by tin and solder, with a few notes on the copper-tin equilibrium diagram. The cracking of stressed brass articles by a process of intercrystalline penetration when in contact with molten solder of the tin-lead variety is associated with the phenomenon of 'season-cracking' and the penetration of mercury into brass. Tensile tests upon brass test-pieces surrounded by various molten metals and solders indicate that the stress required for penetration to take place is much higher than that required for the penetration of mercury. The eutectic composition of the series copper-tin alloys occurs with about 0.7 per cent. of copper as against 1 per cent. by Heycock and Neville, 2 per cent. by Guertler, Shepherd, and Blough, and 5 per cent. by Giolitti and Tavanti.—Harold J. Hartley: The attack of molten metals on certain non-ferrous metals and alloys. Penetration of the molten into the solid material occurs when the latter is stressed in tension. Fully annealed materials are attacked at very low stresses with ultimate breakdown.—H. Moore and S. Beckinsale: Notes on the manufacture and properties of hairsprings. To raise the elastic limit to the required degree, hardening by heat-treatment or by cold-working is necessary, but all hardening operations are liable to produce a state of imperfect elasticity detrimental to the spring. The use of low-temperature heat-treatments to restore elasticity after cold-working (drawing, rolling, and the coiling of the spring) is described. Steel hairsprings are subject to corrosion, but elinvar is highly resistant.—F. Hargreaves: (1) The application of strain methods to the investigation of the structure of eutectic alloys. Investigation of the lead-tin, tin-zinc, and copper-silver eutectics shows that straining by suitable methods results in markings due to slip,

similar to those which occur in the case of pure metals. The orientation of the lead-tin eutectic is apparently determined by that of the tin. (2) Note on the crystallisation of the lead-tin eutectic. Straining and etching methods applied to a 30-lb. ingot of lead-tin eutectic show the exterior to possess the largest crystal size with absence of distinct colonies. The middle consists of much smaller crystal units in the form of distinct colonies of coarser eutectic structure.—J. D. Grogan: The influence of calcium on aluminium containing silicon. With an appendix on the estimation of calcium in aluminium alloys by P. G. Ward. Calcium combines with the silicon present in commercial aluminium, forming a compound, probably CaSi_2 , which is almost insoluble in solid aluminium at all temperatures and exerts no age-hardening influence. By removing silicon from solid solution in aluminium, calcium improves the electrical conductivity of the latter.—M. Hansen: Note on the magnesium-rich magnesium-copper alloys. Some indication of the phase boundary of the solid solution of magnesium with copper has been obtained. The quenched alloys show no perceptible hardening by ageing.—R. Genders: The mechanism of inverse segregation in alloys. With an appendix on the accurate determination of copper in bronze by electrolysis by R. A. F. Hammond. None of the hypotheses which has been put forward to account for the occurrence of inverse segregation in alloys is fully in accordance with experimental fact. Some further factor must be taken into consideration. In extreme cases of inverse segregation, exudation at the surface of the casting occurs simultaneously with the escape of evolved gases. The variation of composition in chill-cast slabs of bronze containing 5 per cent. tin made by various methods of casting were determined. Considering the flow taking place in the mould during the formation of the ingot in relation to these results, a general theory of inverse segregation is advanced, in which the gas constituent in alloys is considered as part of the system. The evolution of gas from solution in the metal is regarded as of primary importance in determining variations in composition in the solid casting.—K. Honda and H. Endo: Magnetic analysis as a means of studying the structure of non-magnetic alloys. The present investigation is to show by means of examples that magnetic analysis applied to the case of non-magnetic elements, which are paramagnetic or diamagnetic, affords a convenient method of studying the equilibrium diagram for the alloys consisting of these elements. Not only is the melting point or the transformation point of an element given by a sharp discontinuity of the susceptibility-temperature curve, but the liquidus and the solidus of an alloy are also marked by a sharp break or bend. In some cases, small solubility is marked by a very large abrupt diminution of the diamagnetic susceptibility of one component on adding a small quantity of the other. Magnetic analysis is also convenient for the study of the actual state of an alloy when above its melting point, that is, in detecting the existence of an intermetallic compound in the liquid phase, the degree of dissociation of the compound with the rise of temperature, etc.—J. Newton Friend and W. E. Thorneycroft: Note on the silver contents of Roman lead from Folkestone and Richboro' Castle. Specimens of Roman lead from Folkestone and Richboro' Castle contained 0.0072 and 0.0078 per cent. respectively of silver.

Geological Society, Mar. 9.—L. J. Chubb and W. Campbell Smith: The geology of Maiao (Society Islands). Maiao, or Tubai Manu, which lies some 50 miles west of Tahiti, consists of a small volcanic

island about a mile long and 500 feet high, encircled by a barrier-reef six miles in diameter. The volcanic rocks collected from the central island include a basalt with numerous phenocrysts of olivine and augite, of the type known to be abundant in Tahiti and the Austral Islands, a phonolitic nepheline-tephrite, and an olivine-bearing basaltoid nepheline-tephrite somewhat similar to those described from Rurutu.—C. I. Gardiner: The Silurian inlier of Woolhope; with palaeontological notes by F. R. C. Reed. The beds seen in the inlier are those between the Llandovery and the Downtonian. The uppermost beds frequently show a slightly eroded surface, and on this rests a conglomerate of clay-pebbles or limestone fragments full of fish remains, forming the base of the Downtonian. Higher up come false-bedded sandstones and shales, and the highest beds seen are sandstones yielding *Lingula cornea*. The inlier has been affected by pressures in two directions. One from the south-west has markedly affected the southern portion of the inlier, at places bringing Downtonian deposits into contact with the Wenlock Limestone. The main result was the bending of the Silurian rocks into an anticline. Pressure also produced an anticline, the axis of which runs north-north-east and south-south-west. The two pressures have produced a more or less dome-like arrangement of the beds, but much faulting has gone on in parts of the area near Sollers Hope, Old Sufton, and Woolhope Cockshoot. Dr. F. R. C. Reed describes fourteen new species and five new varieties of brachiopods, lamellibranchs, gastropods, and trilobites.

Optical Society, Mar. 10.—Basil Graves: Microscopy of the living eye. The uses and advantages are illustrated of using a narrow beam of light for illumination and arranging that the axis of observation is so positioned as to place the object under view in the most favourable condition for observation, against a bright or dark background as the case may be. The non-coincidence of the observing and illuminating axes also enables troublesome specular reflections from the corneal and lens surfaces to be eliminated. Illumination by means of the reflection of the narrow beam from the iris, termed by the author 'retro-illumination,' is described. The rendering visible of the track of the light beam through the ocular media is explained and a term 'relucency' suggested for this property. As the result of continued observation over a period of years, the probable duration of certain conditions, in the crystalline lens for example, is capable of estimation.

Physical Society, Mar. 11.—G. M. B. Dobson and I. O. Griffith: Measurements of absorption coefficients of light filters. A portion of the slit of a spectrograph is covered by the absorbing medium, and in front of the photographic plate or of the slit a neutral wedge is placed. The resulting spectrogram consists of two parts, one due to light which has passed through the filter and the wedge, the other to light which has traversed the wedge only. From a knowledge of the distance between two points, one in each part of the spectrogram, which are of the same density, the absorption coefficient of the filter at any wave-length may be determined. The source of light need not be constant.—T. L. Ibbes and L. Underwood: A comparison of the behaviour in thermal diffusion of nitrogen and carbon monoxide, and of nitrous oxide and carbon dioxide. The gas analysis required in the measurement of the effect is made by means of the Shakespear katharometer. The behaviour of nitrogen is similar to that of carbon monoxide. The effect given by carbon dioxide is generally a little greater than that given by nitrous oxide. The pairs of gases

examined provide a special case for the application of the Enskog-Chapman theory, as in each pair the molecular weights and mean collision areas are the same. It can thus be deduced that the molecular field of nitrogen is similar to that of carbon monoxide, and that the field of carbon dioxide differs little from that of nitrous oxide.—Robert R. Nimmo: Relighting of a neon lamp when momentarily extinguished at voltages below the striking potential. The time for which the continuous discharge of a neon lamp may be interpreted without putting out the lamp is of the order of 50 micro-seconds and depends on the voltage across the lamp and on the current passing through it.—G. B. Deodhar: Electricity of dust clouds. The factors governing the phenomena of electricity of dust storms are: (1) Material of the dust; (2) its size; (3) the gas raising the cloud; (4) the velocity of the gas; (5) the temperature. The first two factors are discussed. The electricity developed is of frictional nature. Some quantitative estimates of electrification of chlorides and nitrates of sodium and potassium are made, showing that chlorides of sodium and potassium are equally efficacious, whilst sodium nitrate is about $4\frac{1}{2}$ times as efficacious as potassium nitrate. Using prepared and graded dusts, it is shown graphically that, other things being the same, the number of volts developed by blowing increases very rapidly as the size grows less.

Mineralogical Society, Mar. 15.—C. E. Tilley: A melillite-spurrite- Ca_2SiO_4 assemblage from Larne (Antrim). This contact metamorphic assemblage, together with mervinite, perovskite, wollastonite, ægirine, and other minerals, occurs at the borders of Cretaceous limestone and a Tertiary dolerite near Larne. The rocks give evidence of considerable chemical interchange during metamorphism.—G. T. Prior: Alkaline rocks from Nimrud volcano, Armenia. Nimrud was a centre of eruption of alkali rocks similar to those of the Rift Valley, East Africa. The lava forming the main mass of the rim and the floor of the crater is a soda-rhyolite (comendite) containing anorthoclase feldspar and the soda-pyroxenes and soda-amphiboles ægirine, cossyrite, and riebeckite. More basic lavas overlying the soda-rhyolites resemble the kenytes of East Africa in containing numerous corroded phenocrysts of anorthoclase. Ordinary olivine-basalts with phenocrysts of labradorite also occur.—G. Greenwood: Rotating crystal X-ray photographs. The first part of the paper deals with this method of crystal analysis as used in the German laboratories, where it was studied by the author. Two substances, tetramethylammonium iodide $\text{N}(\text{CH}_3)_4\text{I}$ and tetraethylammonium iodide $\text{N}(\text{C}_2\text{H}_5)_4\text{I}$ were investigated. The unit cell of $\text{N}(\text{CH}_3)_4\text{I}$ is a tetragonal unit of dimensions $a=8.05 \text{ \AA.U.}$ and $c=5.75 \text{ \AA.U.}$, and the space group is either D_2^2 or V_2^2 , most probably the latter. Hence the crystal class is not the holohedral one proposed by L. Vegard. The unit cell of $\text{N}(\text{C}_2\text{H}_5)_4\text{I}$ has dimensions $a=12.29 \text{ \AA.U.}$, $c=6.82 \text{ \AA.U.}$ when referred to the axes demanded by the scalenohedral space group V_2^2 to which the substance belongs. A smaller unit can be found, using as a axis half the base-diagonal; the cell then has $a=8.86 \text{ \AA.U.}$ and $c=6.82 \text{ \AA.U.}$ The nitrogen and the iodine atoms in both substances are crystallographically identical, but the methyl and ethyl radicles may be half of one kind and half of another. The hypothetical structures suggested for these substances by Groth, as deduced from topic axes, are also discussed.—L. J. Spencer: Biographical notices of mineralogists recently deceased (third series). The average age of the forty lives described was sixty-eight years.

Royal Meteorological Society, Mar. 16.—G. I. Taylor: Turbulence (Symons Memorial Lecture). Turbulence is a condition of motion in a stream of fluid which occurs when it flows past solid surfaces or when two layers of fluid flow over one another. Turbulence increases the diffusing power of air until it is 100,000 times as great as that of air at rest. So great is this effect that in the case of tidal motions in the sea it is possible to prove that turbulence is responsible for the gradual slowing down of the earth's rotation, and consequent lengthening of the day which astronomers have been able to observe. Some observations of the details of turbulence show that eddying motion in the atmosphere is spread out equally in all directions in space.

DUBLIN.

Royal Dublin Society, Feb. 22.—E. J. Sheehy: The correlation of nutritive value with dry matter content of pastures. Two pastures, in which the nutritive value or stock-carrying capacity was in the ratio of about 3 to 1, were compared. The chemical analysis of the dry matter of the herbage—total nitrogen, ether extract, crude fibre, nitrogen-free extract, and total ash—showed no material difference, nor did the digestibility of the herbage from the two pastures differ. A difference in dry-matter content, which amounted to about 25 per cent. in favour of the richer pasture, was revealed; and a correlation was established between the dry-matter content and the proportions of grasses, clovers, and broad-leaved miscellaneous plants (weeds) present.—J. Wilson: The maintenance requirements of cattle on different kinds of rations and at different rates of production. Contrary to Kellner's and Armsby's assumption, it has been shown that maintenance not only rises with the rate of production, but that the rise is accelerated as the rate of production rises. The present paper discusses 'dynamic action' and suggests that such action is really a part of the digestive process, and the heat set free a result of the work done.

PARIS.

Academy of Sciences, Mar. 7.—The president announced the death of Charles Graebe, *correspondant* for the Section of Chemistry.—Mesnager: The rectangular beam loaded at a point. Angle under the charge when it becomes infinitely long. Consequences for plates.—André Blondel: Methods for position-finding by Hertzian waves.—E. Mathias: Contribution to the study of fulminating material (lightning): examples of spontaneous decomposition.—M. Potron: The distribution of a system of integers in groups of given sums.—Beniamino Segre: The diagrams of probability.—Paul Alexandroff: A new generalisation of the Phragmén-Brouwer theorem.—Jacques: Networks the tangents of which belong to linear complexes.—G. Pólya: A theorem of Hadamard relating to the multiplication of singularities.—Hadamard: Remarks on the preceding communication.—P. Tzitzéica: A certain system of partial differential equations.—D. Riabouchinsky: Some cases of cavitation.—Raoul Ferrier: Planck's oscillator.—Nicolas Kryloff: The approximate integration of some partial differential equations of mathematical physics.—Léon Brillouin: The statistics of light quanta (photons).—H. Pélabon: Rectifying contacts.—S. Piña de Rubies: The arc spectrum of gadolinium. Measurements made at the normal pressure, between $\lambda 3100$ and $\lambda 2200$.—H. Jędrzejowski: The ionising powers of RaB and RaC .—F. Bourion and E. Rouyer: The determination, by the boiling-point method, of the affinity relative to the formation of complex com-

pounds between cadmium halides and the alkaline halides.—H. Devaux and E. Aubel: The absorption of ions by glass. The surface of glass (glass wool) is capable of absorbing the ions Ca, H, K, Na, NH₄, quinine, and the action is reversible. Glass behaves as a gel, since adsorption takes place not only at its surface but also in its mass.—J. E. Verschaffelt: The specific heats of a sufficiently cooled condensed phase. An adverse criticism of a recent communication under the same title by M. Perrakins.—Henri Marcelet: The heats of combustion of some oils of marine animals. Data are given for eight samples of oil, ranging from 8700 cal. to 10,790 cal. per gram.—A. Travers and Jouot: The iodometric estimation of the antimonious ion. The reaction between antimonious salts and potassium iodide is complete in the presence of a considerable proportion of concentrated hydrochloric acid.—Ch. Courtot and C. Vignati: Researches in the fluorene series.—André Meyer: The sulphonation of anthraquinone in the presence of mercury.—Ch. Maurain: The distribution of earthquakes in latitude. A statistical study shows that the frequency of earthquakes is greater the smaller the latitude.—D. Faucher and E. Rougetot: Contribution to the study of the mistral.—P. Martens: The vital structure of the nucleus and the action of fixing reagents.—A. Guillaumond: Cytological and taxonomic observations on yeasts of the group of the *Sporobolomyces*.—J. Szymanek: Some observations on the morphology of the mycelium and suckers of *Phytophthora infestans* in the tubercle of the potato.—Boodan Varitchak: The development of the perithecium in *Cordyceps militaris*.—P. Cappe de Baillon: The descendance of double monsters of phasmids.—Maurice Fontaine: The comparative compressibility of the serum and the blood globules of the horse. The blood serum of the horse is less compressible than an isotonic solution of common salt. The complete blood is less compressible than the serum of the same blood.—Roger Douris and Georges Giquel: A method of differentiation of pathological sera (cancer, syphilis, tuberculosis). The characters of cancer serum. The turbidity produced by the addition of varying quantities of distilled water to the serum is compared with the same serum diluted with 0.9 per cent. sodium chloride solution. The difference in the optical density of the two tubes is determined in the Yvon photometer. The differences observed with normal sera are given by numbers between 0 and 3, for syphilitic sera, numbers between 3 and 10. If the number is higher than 10, under the experimental conditions described, the diagnosis is in favour of cancer.—Y. Manouelian and J. Viala: *Encephalitozoon Negrin*, the parasite of encephalomyelitis in young dogs.—A. Borrel: The verminous etiology of certain cancers.

GENEVA

Physical and Natural History Society, Mar. 3.—F. Chodat: The importance of isoelectric points in the preparation and activity of ferments. The author has studied the mother-liquors of the following ferments: saccharogenase, prunase, catalase, tyrosinase. In most cases several minima of dispersion occur in hydro-alcoholic media which are considered as indices of isoelectric points, each minimum corresponding to one of the amphoteric electrolytic colloids which are dispersed in the extract.—S. C. Guha: The preferential electric conductivity of the pistil of some plants. The pistil of the plants studied shows a basipetal preferential conductivity for the incident current, a difference which disappears after pollination.—E. Briner and A. Schidlof: The ebullioscopic paradox. It is established by calculation that external work is effected by the atmospheric pressure

during the condensation of the vapour, and that this work is much higher than the compensating work, evaluated on the basis of a reversible transformation.—E. Cherbuliez and P. Rosenberg: Researches on the silicates. Having applied the determination of electrical conductivity to kaolin, quartz, and orthose, and to their mixtures, the authors have proved that kaolin presents very large variations as a function of the time to reach a limiting value, and this for several values of the temperature. The phenomenon is irreversible and follows the law of a monomolecular reaction.—P. Balavoine: The refractometric estimation of alcohol in fermentation products. The refractive indices of wine distillates have been examined, and it is shown that the volatile acidity of these distillates (mainly due to acetic acid) modifies these indices in a manner not permitting the use of an empirical correction table. A table has been prepared, based on the experimental data, which agrees well with the pycnometric measurements.—R. Wavre: The stratification of the planets and Fredholm's equation. Fredholm's equation, to which the problem of the stratification of the planets may be reduced, possesses a symmetrisable nucleus.

VIENNA.

Academy of Sciences, Feb. 17.—A. Kieslinger: Second preliminary report on geological petrographic researches in the Southern Kar Alps of Styria. A survey of the Kar Alps district including Unterdrauburg and Deutschlandsberg-Wolfsberg. The present reports concern metamorphic rocks and a series of mineralogical peculiarities—destratification (*Entschieferung*), deformations (*Verwachsungen*), recrystallisation (*Umkrystallisieren*), rough injected mica schist (*Glimmerschiefer*). Between the textures of the injection-changed rocks emerge remains of still older textures (*Durchbewegungstexturen*). The lamelliform gneisses with streaky texture are clearly intrusive rocks.

Official Publications Received.

BRITISH.

- Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 2, No. 2, March. Pp. 91-197. (Cambridge.) 12s. 6d. net.
- Aeronautical Research Committee: Reports and Memoranda No. 1054 (M. 48): The Variation in the Fatigue Strength of Metals when tested in the Presence of Different Liquids. By G. D. Lehmann. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (E F 154.) Pp. 13-14 plates. 1s. net. No. 1056 (Ae. 239): Algebraic Formulae for the Performance of an Aircraft at Full Throttle. By R. S. Capon. (D.1.) Special Technical Questions, 151.—T. 229d.) Pp. 13. 9d. net. (London: H.M. Stationery Office.)
- Colony and Protectorate of Kenya. Agricultural Census: Seventh Annual Report, 1926. Pp. 34 (Nairobi: Department of Agriculture.)
- The British Mycological Society. Transactions. Edited by Carleton Rea and J. Ramsbottom. Vol. 12, Part 1, March 23. Pp. 77+10 plates. (Cambridge: At the University Press.) 7s. 6d. net.
- More Books to Read (1920-1926) on Social and Economic Subjects. A Supplement to "What to Read," containing Publications from December 1920 to December 1926. Pp. 80. (London: The Fabian Society.) 6d.
- Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 38, Part 1, March 21st. Pp. 144. (London: Edward Stanford, Ltd.) 5s.
- Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1925-26. Pp. 11+79+4+8 plates. (Madras: Government Press, 1926.) 12 annas.
- Madras Agricultural Department. Year Book, 1925. Pp. 11+63+12 plates. (Madras: Government Press.) 1 rupee.
- Astrographic Catalogue 1900.0. Sydney Section, Dec. -51° to -65°. From Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 7. R.A. 12^h to 18^h, Dec. -52° to -54°, Plate Centres Dec. -53°. Pp. 63. Vol. 8. R.A. 18^h to 24^h, Dec. -52° to -54°, Plate Centres Dec. -53°. Pp. 32. (Sydney, N.S.W.: Alfred James Kent.)
- Transactions of the Geological Society of South Africa. Vol. 29, containing the Papers read during 1926. Pp. iv+150+17 plates. 42s.
- Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussions on Papers read during 1926; to Accompany Vol. 29 of the Transactions, January-December 1926. Pp. iii+xliv. (Johannesburg.)

Nyasaland Protectorate: Annual Report of the Geological Survey Department for the Year 1926. Pp. 6. (Zomba: Government Printer.)
 Agricultural Research and Administration in the Non-Sovereign Dependencies. Report of a Committee appointed by the Secretary of State for the Colonies. (Cm. 2327.) Pp. 101. (London: H. Stationery Office.) 2s. net.

Papers from the Geological Department, Glasgow University. Vol. 16 (Quarto Papers of 1926) (Glasgow University Publications 7.) Pp. iv + 5 papers. Vol. 11 (Octavo Papers of 1926) (Glasgow University Publications 8.) Pp. iv + 12 papers. (Glasgow: Jackson Wyre and Co.)
 The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 56, July to December 1926. Pp. x + 295-487—plates 16-51. (London.) 15s. net.

Royal Astronomical Society. List of Fellows and Associates. Pp. 52. (London.)

The Gravesend and District Scientific and Archaeological Society. Proceedings, 1925-26, and Second Annual Report, April 1st 1925 to March 31st 1926, with Lists of Entomological Captures, and Flowering Plants of the District, and Descriptions of the Ancient Buildings in the Locality. Pp. 20. (Gravesend: The Borough Library.)

The National Physical Laboratory. Report for the Year 1926. Pp. 260. (London: H. M. Stationery Office.) 7s. 6d. net.

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 1, No. 6: The Distribution of Anopheline Mosquitoes in Scotland. By Prof. J. H. Ashworth. Pp. 81-98. 1s. 6d. Vol. 47, Part 1, No. 7: A Study of the Fertilisation Membrane in the Echinoderms. By A. D. Hobson. Pp. 94-117. 2s. 3d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Directory of Members of the Association of Tar Distillers. Pp. 15. (London: 166 Piccadilly.)

FOREIGN.

Zentralanstalt für Meteorologie und Geodynamik. Publikation Nr. 129: Jahrbuch der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1923. Neue Folge, Band 60. Pp. xiv + A42 + B40 + C92 + D4. Publikation Nr. 130: Bericht über die 13. Versammlung des Internationalen Meteorologischen Komitees in Wien, September 1926. Pp. 54. (Wien.)

Department of Commerce: U.S. Coast and Geodetic Survey. Hydrography. Serial No. 317. Construction and Operation of the Wire Drag and Sweep. By Lt.-Comdr. J. H. Hawley. (Special Publication No. 118.) Pp. iii + 64. (Washington, D.C.: Government Printing Office.) 10 cents.
 Department of the Interior: Bureau of Education. Bulletin, 1926, No. 22: A Manual of Educational Legislation. Pp. v + 67. (Washington, D.C.: Government Printing Office.) 15 cents.

Connell University Agricultural Experiment Station. Bulletin 457: An Index Number of Farm Taxes in New York, and its Relation to various other Economic Factors. By M. Slade Kendrick. Pp. 47. Memoir 102: A Cytological Study of Two Types of Variegated Pericarp in Maize. By Fannie Rane Randolph. Pp. 14 + 2 plates. (Ithaca, N.Y.)

Methods and Problems of Medical Education (Sixth Series.) Pp. iii + 275. (New York: The Rockefeller Foundation.)

Diary of Societies.

MONDAY, APRIL 18

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—Annual General Meeting.
 CHEMICAL INDUSTRY CLUB.

WEDNESDAY, APRIL 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—First Report of the Committee on the Relation between Atmospherics and Weather, entitled The Range of Atmospherics. "Opener of discussion, R. A. Watson Watt.
 NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street, E.C.), at 5.30.—F. Achard and L. Seguin: Marc Seguin and the Invention of the Tubular Boiler.
 INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—A. Tustin. Some Magnetic Problems.
 FOLK-LORE SOCIETY (at University College), at 8.—Mrs. A. Morgoci: The Devil in Roumania.

THURSDAY, APRIL 21.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. Gordon Holmes: Local Epilepsy (Savill Memorial Oration).
 INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Annual General Meeting.
 INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. E. W. Marchant: High-Frequency Currents (Kelvin Lecture).
 INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—W. G. Ruggins: Repairs.

FRIDAY, APRIL 22.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 3.30 and 5.45.—General Discussion on The Theory of Strong Electrolytes. Part I. Mobilities of Ions.—P. Debye: Introductory Paper. Report on Conductivity of Strong Electrolytes in Dilute Solutions.—L. Onsager: Report on a Revision of the Conductivity Theory.—K. Fajans: Refractometric Evidence for the Existence of Undissociated Molecules and Complex Ions in Solutions of Strong

Electrolytes.—H. Benay: Electrolytic Transference of Water, True Transference Numbers, Ionic Mobilities and Water Sheaths of the Ions.—H. Uchel: Ionic Mobilities in Non-aqueous Solvents.—H. Hartley and H. R. Harkes: The Mobilities of the Elementary Ions in Methyl Alcohol.—H. Hartley and R. P. Bell: Notes on the Debye-Hückel Theory.—D. A. MacLennan: The Ionisation of some typical Strong Electrolytes.—Prof. A. J. Allmand and L. J. Burrage: A Thermodynamical Study of the System Lead Chloride-Potassium Chloride-Water at 25°C.—Prof. A. J. Allmand: Note on the Occurrence of Points of Inflection in the Concentration-Vapour Pressure Curve of Aqueous Solutions of certain Electrolytes.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting) at 7.—Major C. H. Douglas: The Engineering of Distribution, with special reference to Finance as a Form of Organisation.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane, E.C.), at 7.—Members' Evening.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. D. Holland: Shock Absorber Units for Land Planes.

SATURDAY, APRIL 23.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 9.30 A.M., 11.30 A.M., and 2.15.—General Discussion on The Theory of Strong Electrolytes. Part II. Activity.—J. N. Brønsted: Introductory Paper. On the Activity of Electrolysis.—R. H. Fowler: Strong Electrolytes in Relation to Statistical Theory, in Particular the Phase Integrals of Gibbs.—D. L. Chapman: Note on the Theory of Debye and Hückel.—N. Bjerrum: Anomalies in the Theory of Solutions of Strong Electrolytes.—G. Scatchard: Mixed Solutions of Electrolytes and Non-electrolytes.—H. S. Harned: On the Thermodynamic Properties of a few Concentrated Salt Solutions.—F. Foxton and W. J. Shutt: The Activity of Zinc Chloride in Concentrated Solution.—C. A. Kraus: Influence of Salts on Solubility in Non-aqueous Solvents.—J. H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley: The Use of Amalgam Electrodes for determining Activities in Methyl Alcohol.—M. Randall: (a) The Significance of the Activity Coefficient; (b) Methods of Calculation of Activity Coefficient.—Prof. J. R. Partington: Electrochemical Properties of Non-aqueous Solution of Strong Electrolytes.—Prof. T. M. Lowry: The Definition and Characteristics of Strong Electrolytes.—H. Millet: The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at County Hall, Ipswich), at 10.45 A.M.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow)—Annual Meeting.

CONFERENCES.

APRIL 19 AND 20.

SOCIETY FOR EXPERIMENTAL BIOLOGY.

April 19 (in Physiological Institute, Cambridge).

At 2.15—

Prof. R. R. Gates: An Investigation of Quantitative Inheritance.

E. M. Delf: Effects of Ultra-violet Light on Plants.

At 3.45—

J. Gray, D. Bhatia, and H. Standfast: The Growth of the Trout.

Prof. H. Hartridge and F. J. Roughton: The Velocity of Certain Biological Reactions.

Miss Henderson and Miss Spenser: The Influence of the Corpuscle as such on the Phase of Haemoglobin.

A. Walton and J. Hammond: Ovulation in the Rabbit.

J. B. S. Haldane: Some Effects of CO.

At 4.30—

Dr. G. V. Anrep: Inhibition as an Integral Part of Cortical Activities.

Dr. A. S. Parkes: The Relation of the Corpus Luteum to Oestrin.

April 20 (in Zoological Building, Cambridge).

At 10 A.M.—

J. B. S. Haldane, G. C. Robson, C. Diver, and Dr. F. A. E. Crew:

Symposium: Evolution and Heredity.

At 2.15—

J. T. Saunders: Chemotaxis in Protozoa.

Dr. E. D. Adrian: The Investigation of the Sense Organs in Animals.

At 4.30—

J. Gray: The Effect of Gravity on Cell-division.

Prof. J. S. Huxley: Artificially Induced Metamorphosis in Echinus.

APRIL 20 TO 24.

JOURNÉES MÉDICALES MARSEILLAISES ET COLONIALES (at Marseilles).—Prof. Cantacuzène: The Role of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden)—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haensch and Lorey, and Fleischner.



SATURDAY, APRIL 23, 1927.

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The State and Industrial Research.

IN July 1915 the Government announced the appointment of a special committee of the Privy Council and the establishment of a permanent official organisation for the promotion of scientific and industrial research. As an integral part of the organisation "a small Advisory Council, composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research," was established by Order in Council. There already existed large national responsibilities for the conduct of scientific inquiry in connexion with the fighting services, agriculture, fisheries, and medicine, but save for the last, these were subordinate activities of ministries with many other responsibilities. The unique feature of the new organisation lay in the fact that it definitely put the scientific man in the saddle, for all proposals for allocating the funds placed at the disposal of this body stand referred to the Advisory Council.

The need for such an organisation was forced upon Great Britain by the sudden realisation of its dependence on foreign countries for certain essential raw materials and manufactured goods, particularly those goods which were based upon the application of scientific discoveries to industrial processes. It was realised, moreover, that our industrial ascendancy had been challenged, if not wrested from us, by the capacity for organisation displayed by our commercial rivals, particularly Germany, and that organisation could only be met by counter-organisation.

It was in this spirit that the idea of the co-operative industrial research associations was conceived. As the Advisory Council remarked at the time:

"so long as the Englishman treats his business house as his business castle, . . . with his hand against the hand of every other baron in his trade and no personal interest in the foreign politics of his industry as a whole, it will be as impossible for the State to serve him, whether by research or other means, as it would have been for King Stephen to conduct a campaign abroad. In the main the State can only effectively help those who help themselves."

The essential individualism of the average English industrialist was accompanied by a lack of appreciation of the function of systematic scientific research. A managing director of a manufacturing firm, and regarded as typical, informed the Advisory Council that he had no interest in research which did not produce tangible results within a year. In the face of this attitude the Advisory Council came

to the conclusion that it would have to "expend a good deal of attention and money upon convincing the manufacturing world in general that scientific research is a paying proposition," and that unless the generality of British firms could be induced to alter their attitude it would have failed profoundly in one of its appointed tasks. Little, however, could be done until 1918. In the years following 1916, when the whole energies of the nation were bent to one purpose, and the whole of the existing supply of scientific workers were either engaged at the front or in urgent national services at home, it was difficult to put any policy involving individual firms into effect.

Even if the Advisory Council had had the time at its disposal and could have gained the ready acceptance by individual manufacturers of a policy of co-operative research, it was confronted with the serious difficulty of finding the research workers. Some industries, temporarily impressed with the need for men of scientific training, could not obtain them. To meet this demand, the Department instituted, a few months before the Armistice, a system of maintenance allowances to suitable students to spend two years in scientific research under direction at a university. Thus it was hoped to re-establish "a body of scientific workers of the highest rank for purely scientific work, and to enable men who intended to make some branch of industry their profession to equip themselves for scientific work in industry." In the same year, 1918, from a Million Fund put at the disposal of the Advisory Council, the first co-operative research associations were started, those for the scientific instrument and photographic industries in July, and the first of the textile research associations, that for the woollen and worsted industry, in October. In all, twenty-seven research associations have been formed under the State-aided scheme, twenty-three of which survive.

It was hoped and contemplated when the scheme was inaugurated that the industrial research associations would become self-supporting within five years—that that period would be sufficiently long to convince the subscribing firms of their utility. But some of the associations have gone into liquidation through lack of support, and most of the others, even the most successful, are still in receipt of grants. Two reasons are advanced for this by the Advisory Council: the difficult conditions during the post-War years, continued political and social unrest throughout Europe with its consequent trade depression, and the continued

apathy of many of the subscribers towards research, many of them regarding their subscriptions to the associations as contributions to a benevolent organisation to be reduced or withheld in bad times. Individualism of the old order has still to be broken down. British manufacturers as a whole have still to realise that co-operation is not the negation of individual effort, but that, on the contrary, it raises initiative to a higher power. Too few regard scientific research as an insurance against industrial bankruptcy. In too many instances, moreover, the subscribing firms have not the capacity to appreciate the research work which is being done. They are intellectually incapable of understanding their own problems. They confuse research with invention.

Other factors also operate against the research associations. They are competing with private consultants, many of whom have a wealth of experience and knowledge at their command, and have long enjoyed the confidence of their clients. Then again, many industrial firms prefer either to do most of their own research, if necessary submitting special problems to members of university staffs. Some of the most enlightened industrialists subscribe to the research associations, not with the primary object of submitting their principal and most promising problems to them, but rather for the purpose of obtaining information regarding the problems confronting other industrialists. The problems they refer to the research associations are often of greater academic than practical importance.

Considering the state of public opinion and the industrial unrest which prevailed at the time when most of the research associations were started, it must be confessed that the Advisory Council was unduly optimistic in expecting the associations to become self-supporting within five, or even ten, years. This is most evident in those industries in which the scientific principles underlying the processes of manufacture are little understood. The textile industries, for example, have been brought to a high standard of efficiency as the result of experience and manipulative skill, but little is known of the physical qualities of the materials used or the precise nature of the properties required in the ultimate product. Knowledge of the latter must be combined with acquaintance with the former. The research workers are therefore faced with the initial necessity of acquiring knowledge of the processes before they can hope to secure the confidence of the industries.

Laboratory research is in itself a tedious process;

further experimentation with small-scale plant is usually necessary before the final and more costly stage is reached of experimenting on a full commercial scale. The fact was recognised by the Advisory Council that nothing short of a revolutionary change in our industrial processes, based upon fundamental research, would raise British industries from the slough into which they had fallen, but the time-lag between a scientific discovery of practical importance and its industrial application was much underestimated. Commenting on a memorandum submitted by the Department of Scientific and Industrial Research, the Committee of Industry and Trade stated that:

"The results so far achieved by the Research Associations as a whole . . . have been for the most part rather of an educational value to the industries concerned than of a kind which can be assessed in terms of actual monetary saving or gain. . . . The initial period of five years . . . has in fact proved too short a period in the case of most of the associations to yield practical results sufficiently clear and striking to convince the sceptics within the industry of the money value to their businesses of fundamental scientific research."

There is another aspect of the matter which the Advisory Council overlooks. A large number of young and enthusiastic research workers were attracted to the service of these associations, not so much by high initial salaries as by the promised interest of the work, and the prospects held out to them. Most of them fondly imagined that a change of attitude on the part of industry had brought the associations into being. But many have spent some of the best years of their life in trying to combat the prejudice against 'science' which still exists, working under difficulties throughout, and now are faced with the possibility of their work and knowledge being relegated to the limbo of forgotten enterprises.

Can the State afford to lose the results of the work of these men because industries are not yet sufficiently aware of their responsibilities to the nation? This is a question which will have to be decided before the second period of five years has elapsed. We cannot agree that it is only the industrialists themselves who are concerned with industrial research. The conduct of industry is of supreme importance to the nation as a whole. The doctrine that "the future of research associations must rest with the industries concerned, since the State cannot be expected to support indefinitely organisations instituted primarily for the benefit of the industries themselves," as enunciated by the Department, cannot be accepted. In comparison

with countries like Germany—which has had far more post-War difficulties to contend with than Great Britain—and the United States, Great Britain's expenditure on industrial research is almost trifling. If industry will not equip itself for the task, it is the bounden duty of the State to decide what industrial research is required. The method of raising the funds for the purpose is a matter for the State to decide. It has already been suggested that firms should be forced to contribute to the specialised research affecting their activities. This may not be equitable, since industrial research, like pure research, is the concern of the nation as a whole. It may be found desirable to change the character of the existing associations, to group them differently or to have them centred in the various universities scattered throughout the country. Whatever is decided, the beginning, for that is all it is, is sufficiently promising to justify increased rather than diminished effort to bring home to the country as a whole the fundamental importance of research on a magnificent scale.

Rather more than ten years have elapsed since Sir Frank Heath forsook his studies of Chaucer and Canterbury pilgrims to become one of the leaders in the great pilgrimage of research. He has had to meet many difficulties. The hostility of many men of science who resented the entry of a State department into the scientific and academic world had to be fought: the apathy of industry had to be overcome. He is now about to hand over his responsibilities to Mr. H. T. Tizard, but he retires with the consciousness that his name is inevitably associated with the most successful experiment in administration to which the War gave birth.

The New Outlook in History.

The Human Adventure. (1) *The Conquest of Civilisation.* By James Henry Breasted. Pp. xxv + 717 + 50 plates + 17 maps. (2) *The Ordeal of Civilisation: a Sketch of the Development and World-Wide Diffusion of our Present-Day Institutions and Ideas.* By James Harvey Robinson. Pp. xii + 769 + 59 plates (12 maps). (New York and London: Harper and Bros., 1926.) 16s. net each vol.; 32s. net the set.

IT always arouses one's suspicions if a time-honoured institution which we have known all our days, and know to be the outcome of an immemorial growth, suddenly announces that it has become quite new. Or if a certain number of

its workers set up the claim to a new and inspired method of working, we are apt, and often rightly, to regard them as charlatans or 'bolshheviks,' or whatever may happen to be the fashionable word for a dangerous revolutionary at the time. So it was, and in that case rightly, with those who promised us a new heaven and a new earth as a result of the War, and so in the minds of many is it likely to be with those who are now talking of a new history. The phrase is chiefly current on the western side of the Atlantic, and if we are not mistaken it has been most, if not first, used by one of the two authors of the beautiful work entitled "The Human Adventure," which has just appeared in two volumes, by Prof. J. H. Breasted, the eminent Egyptologist, and Prof. J. H. Robinson. Prof. Robinson, who writes the second volume, on medieval and modern times, is principally identified with this new gospel of history, but Prof. Breasted, who supports him with a massive knowledge of archæology and the ancient world, is at one in thinking that history in our time has entered into another and far more important phase of its development.

What, then, are these recent changes? Are they sufficient to make us think that history has put on a substantially new character? What are the bearings of this new history, new at least in the minds of some who study and teach it, and how far do these two volumes by Messrs. Breasted and Robinson fulfil the ideals that they set before them?

The inquiry, as we might expect before starting, very soon reveals itself as closely similar to that into the evolution of any other great branch of human activity. Take, for comparison, religion, or science, or art. They seem in their fully developed form to differ so widely from their first beginnings that we are apt to think them entirely changed and that we have achieved, or are on the threshold of, a religion or a science—new in kind. Yet, looking back, we can trace a continuous growth and always find somewhere an earlier germ of what we thought was quite new. So in this appearance of a 'new' history one can find antecedents and authority in the works of previous thinkers for all the new ideas and material that are now coming in with a flood. Thucydides and Herodotus could give us examples enough; what is new is the amplitude of the material, the spread of a similar spirit of inquiry from one branch or nation to another; above all, the valiant attempt to see all the facts as part of one process the understanding of which is a matter of essential and

transcendent importance for civilised men. Understood in this sense, we may well allow the claim of a 'new history' to its professors and gratefully acknowledge our debt to Messrs. Breasted and Robinson for their contribution to it in these volumes.

The distinguishing points in the outlook on history which these books so admirably illustrate are mainly these. In the first place, and dominating all the rest, the story is regarded as that of civilisation as a whole, and not merely of the political development, whether of one nation or of any grouping of nations. This involves not omitting wars or the building of states, but seeing these activities as part of the larger process through which mankind has passed from the state of isolation, ignorance, and collective powerlessness in which we first discover our human ancestors, to the comparative unity and vast collective power and knowledge in which we now live.

Three aspects of history at once emerge into prominence as soon as this point of view is taken. One is the importance of the fundamental early inventions and advances in culture which archæology has lately been revealing with a striking similarity from all quarters of the globe. Prof. Breasted is satisfactorily emphatic on this side of his subject, and puts first ploughing, the use of metals, and the invention of writing and the calendar, among the benefits which the ancient Egyptians conferred on their neighbours. It will be noticed that the priority which he assigns to Egypt, not only over the west but also over all the civilisations farther east, lends support to the recent school which turns to Egypt as the nursery of all civilisation. It should also be remembered that such particular questions as the relations between Egypt and Babylonia, or the antiquity and originality of the civilisations of India and China, are detailed matters for further research. They do not affect the main position of putting in their due place these and other aspects of man's contact with Nature as well as with his fellow-man.

Following the same line of thought into later times, the new outlook in history lays stress on the vital importance of the evolution of scientific thought in building up mankind. In this, again, as we might expect, our authors show a right appreciation of the relation of the facts, although one would be glad to see more space assigned to that aspect of progress which has hitherto received practically no treatment at all in general histories. Thus Mr. Robinson points out that the scientific advance which began to be rapid in the seventeenth

century. produced also a general spirit of reform which has dominated the west ever since ; and in a concluding chapter he shows the supreme importance of scientific thinking in promoting the forward-looking habit, based upon continuity with the past. It would be interesting to trace how it is precisely this spirit which inspired the reforming monarchs of the eighteenth century—Frederick the Great, Joseph II., and the rest. The limitations of their success, and the limitations, equally marked though due to other causes, of the philosophers of the Revolution, form one of the most interesting and instructive studies in history, far outweighing the glamour of Napoleon's career, which still occupies the forefront of the stage even in such enlightened books as these. Napoleon, and many like him, passed over the world as a hurricane, clearing away, no doubt, much ill-founded vegetation and structures ; but the work of the thinkers goes on steadily all the time, correcting its mistakes and bringing at last to fruition ideas that ignorance and passion may impede for generations.

It will be understood at once that as soon as we transfer our main attention in history to the general growth of civilisation, rather than the political development of particular States, our view gains in universality as well as continuity with the past. The things that matter most are those which we share with others and not those which divide or distinguish us. It all turns on that, and the acceptance of this fundamental truth does not involve the lowering of mankind to a level of dull and monotonous mediocrity. Eminences will remain, and may be just as beautiful and varied if they arise from a broad and well-based plateau as if they stand isolated and likely to be submerged in a rising ocean. The fundamental facts of civilisation are of this common and connecting kind. Not only in their inventions and their arts of life, but also in their maxims of morality and their earliest ideas of religion, we find ourselves at home when we trace origins, whether in India and China or in Mexico and Peru. Going back we come together, and going forward we may hope to integrate history and the world at large in the same spirit, a spirit not of uniformity or of degradation, but of a common humanity, realising itself in varied forms.

On this matter again it must be said that Prof. Robinson might have imported a little more of the 'eternal spirit' in looking at his facts without depriving them of a tittle of their interest and actuality. The League of Nations is made to

appear in his pages as if it were merely as a part of the Treaty of Versailles, a sequel useful and important, but only a sequel, of the War. It is that of course, but, *sub specie aeternitatis*, it is far more. It is the necessary sequel of the process of unifying the world, in which science and its applications had played so large a part, both in the "Conquest" and the "Ordeal" of civilisation. The "Ordeal" is in fact the question whether the achievements of science in the mechanical sphere are to be used for the furtherance or the destruction of the civilisation which has been conquered : the sharpened razor and the more massive hammer will be the more destructive to life if they are not wisely governed ; and wisdom, like science, is a collective thing, the highest manifestation of common sense. The League of Nations, whether there had been a great war or not, must have been born, and was being born, to give voice to this common sense.

One would have welcomed a little more explicit statement of these truths in the second volume, and a little less of somewhat personal matters in the post-War chapters ; even the excellent and almost full-length portrait of Mr. Ramsay MacDonald does not reconcile one to this want of balance.

On the whole, however, the work in both volumes is well done and is unquestionably the best popular presentation of general history which we have yet acquired in English. Prof. Robinson is more fluent and philosophic ; Prof. Breasted is more solid, and adds more to our knowledge. But he does it in the most attractive way, with admirable pictures, maps, and cross references. The work is a notable step forward in the much-needed operation of informing the general public of the latest results of historical research into the ancient world and of the new and broader outlook in the modern.

F. S. MARVIN.

Elementary Astronomy.

The Elements of Astronomy : a Non-Mathematical Textbook for Use as an Introduction to the subject in Colleges, Universities, etc., and for the General Reader. By Prof. E. A. Fath. Pp. viii + 307. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1926.) 15s. net.

THIS book is a welcome addition to the rapidly growing mass of astronomical literature. It is, in the main, well arranged, clearly written, and adequately supplied with

excellent illustrations and diagrams. There is nothing revolutionary or in any way unconventional in its general plan, and while the most recent researches have been taken into account, the author has not yielded to the temptation of ascribing to intrinsic importance the relative prominence which may actually arise only from their nearness. The book may be generally recommended as an accurate and interesting outline of present-day astronomy.

It is unfortunate, however, that Prof. Fath has attempted the impossible task of achieving two irreconcilable results in a single volume. His work is intended both as a text-book and as a book for the general reader. The characteristics of successful works of these two types under our present system of education are antagonistic. A text-book must be primarily an aid in preparing for examinations, and should therefore present knowledge in the form of 'quanta' which can be reproduced on the examination paper in a period of twenty or thirty minutes. It must draw a perfectly sharp line between what is known and what is unknown, and concentrate attention entirely on the former. This is very regrettable, but it is nevertheless true. The general reader, on the other hand, is interested in astronomy only in relation to life as a whole. He does not want chapter and verse, but only broad results and lines of thought. In brief, while the text-book should describe the individual pebbles on the shore, the book for the general reader should deal only with the relation of those pebbles to the undiscovered ocean of truth from which they have been retrieved.

Prof. Fath's book necessarily suffers from the attempt to unite these two classes of work. As a text-book it lacks something of the precision which is desirable. The treatment of the subject matter is in parts somewhat sketchy, and is almost entirely non-mathematical. It is true that the book is intended for college freshmen, but the college curriculum which includes the teaching of the principles of refraction of light and the methods of determining time, latitude, etc., to students with no knowledge of the rudiments of trigonometry, is open to severe criticism. There is, too, a complete absence of suggestions for practical exercises. It is most desirable that students—and especially beginners—should be encouraged to do things for themselves, and even in those colleges unprovided with simple spectroscopes, transit and equatorial instruments, a great deal may be done with the old-fashioned celestial and terrestrial globes. It will be noticed that these defects of

the text-book are merits of the book for the general reader, who, however, will not welcome the division of the chapters into short numbered paragraphs, each with its own heading.

Allowing for the impossibility of his aim, however, Prof. Fath has probably made as satisfactory a compromise as is possible. A book may fall short of its ideal and still be extremely valuable. We regret that Prof. Fath did not confine himself to a single purpose—or, better still, write two books—but we do not wish to convey the impression that the book is a failure. It will probably be found most useful to the secondary school teacher who, not having to teach astronomy as a definite subject, is yet sufficiently interested in the wider aspects of education to keep his pupils in touch with the general principles and achievements of the most humanistic of sciences. The general reader also who is not repelled by the text-book-like appearance of the paragraphs will read the volume with both pleasure and profit. About two-thirds of the book is concerned with the solar system, so the older astronomy has not been neglected for the more sensational developments of the new. Having regard to the four subdivisions of astronomy defined in paragraph 6, however, the uninstructed reader will probably conclude that the observation of the planets belongs to astrophysics. A fifth subdivision—descriptive astronomy—might well have been included.

There are the few inevitable mistakes, of which only the more serious need be mentioned. Since a paragraph has been devoted to the 'spectrum' of a comet, it should have been stated that the spectra of the head and tail differ from one another. The proposed classification of the nebulae on the basis of spectral type alone is scarcely satisfactory, and the term 'disintegration' of matter, which is used throughout to indicate the probable source of stellar energy, does not convey the true idea of annihilation. The reader who has had faith in the ingenuity of men of science will be surprised by the statement on p. 39 that a converging and a diverging meniscus (not here so called) "cannot be distinguished by their names alone." Finally, Fig. 31 is an almost incredibly erroneous diagram, in which rays of light are suddenly deviated in the midst of a homogeneous medium. It is the most striking example we have met with of the danger of thinking in terms of single rays instead of pencils of light. The book is well produced, and contains few misprints. 2½ lb., however, is an excessive weight for a book of 307 pages.

H. D.

General and Special Mineralogy.

Lehrbuch der Mineralogie. Von Prof. Dr. P. Niggli.
1. *Allgemeine Mineralogie.* Zweite Auflage. Pp. xvi+712. 24 gold marks. 2. *Spezielle Mineralogie.* Unter besonderer Mithilfe von Prof. Dr. L. Weber. Zweite Auflage. Pp. xvi+697. 30 gold marks. (Berlin: Gebrüder Borntraeger, 1926.)

NONE of the foreign guests of the Mineralogical Society on the occasion of its recent fiftieth anniversary was more heartily welcome than Prof. Niggli of Zurich. It is therefore with especial interest that we open the new and greatly enlarged edition of his text-book of mineralogy in two handsome volumes.

The first of these, which deals with the general principles of the subject, is not only a monument of industry and research, but it also displays everywhere the resources and originality of the author. It deals with crystallography at considerable length, paying especial attention to the atomic configuration, as revealed by the Röntgen rays. More stress than usual is laid on the physical characters of crystals, though, as may be supposed, it is their optical properties that are treated in the greatest detail. The principles of crystal chemistry are carefully explained, and space is even found for the subject of glasses and colloids.

The student who has mastered the contents of this volume will have acquired an undoubted mastery of the theory of the subject, though it may be open to question whether it is best for him to owe his training to one great compilation, however accurate, logical, and complete it may be. He might get a broader grasp of the subject if he studied, under the guidance of his teacher, the expositions of different workers who have made themselves responsible for recent advances. There would then be less danger of his adopting stereotyped methods of treatment.

Some years ago, Prof. Hilton introduced the principle of 'rotatory inversions' in describing the symmetry of certain classes of crystals: that is to say, rotations resulting in the coincidence of all crystallographic lines, but with the directions reversed of lines having different properties in opposite directions. This valuable conception, based on the nature of crystal structure, has been since extended to the relation between the component parts of some twinned structures, but it finds no place even in this most comprehensive of text-books.

The second volume, dealing with the individual

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minerals, is no less remarkable. In it, also, special stress is laid on crystallography, which is treated in a somewhat original manner. Crystals belonging to systems with relatively low symmetry are considered to be distorted examples of forms with higher symmetry and classified accordingly. Thus a group of cubic and 'hypocubic' crystals includes not only fluor, which is cubic, but also calcite, which is rhombohedral. Curiously enough, Prof. Niggli does not place the monoclinic baryto-calcite in the same category in spite of the remarkable resemblance of its crystallisation to that of the rhombohedral carbonates. The felspars, too, are referred to hypocubic axes. Pyroxenes are, as one would expect, hypotetragonal, and amphiboles hypohexagonal. These and other similar affinities have long been recognised and were studied in detail by Fedorov. Indeed, the author might have noted an additional link between the cubic and trigonal systems in the fact that fluor and halite, though cubic in their angles and optical characters, exhibit occasionally a development of faces which seems to indicate rhombohedral or even lower trigonal symmetry. But the use of such affinities as the basis of a classification, cutting across the established systems and classes of crystals, which the author still recognises, and branching out into intricate subdivisions, is calculated to confuse the student, while those who are already familiar with crystallographic principles experience a sense of bewilderment when they have struggled through the volume. Yet it undoubtedly contains a store of interesting facts and suggestions.

With all its idiosyncrasies this remarkable book should be found on the shelves of every teacher of mineralogy and crystallography, but he will probably hesitate to place it in the hands of the members of his classes.

J. W. E.

Our Bookshelf.

Introductory Electrodynamics for Engineers. By Prof. E. Bennett and Dr. H. M. Crothers. Pp. ix+665. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 22s. 6d. net.

THIS book aims at giving a thorough grounding to students of superior ability who have a keen interest in their subject. From many points of view it is deserving of high commendation, but the reviewer rather hesitates to recommend it to students in Great Britain, until at least they have passed their examinations. The difficulty is that the authors have introduced some radical changes into ordinary nomenclature. In some cases these changes are desirable, but in other cases they will be apt to lead to confusion at the present time.

The entire treatment of electric and magnetic theory is given in terms of a single system of units instead of three systems. This system, the rationalised practical system, has been freed of the 'irrational' π factors and of the multiplicity of troublesome conversion factors by three expedients: (1) By using the ampere turn and the ampere turn per cm. as the units of magnetomotive force and of magnetic intensity respectively; (2) by using the weber and the weber per sq. cm. as the units of magnetic flux (induction) and of magnetic flux density; (3) by assigning to the permittivity, p_0 , of free space such a value that Coulomb's law becomes

$$f = \frac{q_1 q_2}{4\pi p l^2},$$

where f is measured in *dyne-sevens* (10^7 dynes), q_1 and q_2 are in coulombs, and p is the permittivity of the medium in which the charges are immersed. The value of p_0 in free space is taken as 8.85×10^{-14} . Accepting this notation, we can say that the book is well and clearly written. It contains many useful examples, and several of the methods of discussing well-known theorems are novel and instructive.

Recent Advances in Physiology. By Prof. C. Lovatt Evans. Second edition. Pp. xiii + 370. (London: J. and A. Churchill, 1926.) 12s. 6d. net.

THE appearance of the second edition of this little volume within a few months of the first speaks well for its reception. It is, in fact, an excellent presentment of our knowledge of certain selected aspects of physiology. The author describes it as an "Elementary Text-book of Advanced Physiology"; but we feel sure that most of the chapters could be read with profit by the average medical student. The author has seized the opportunity presented by the need for a second edition to bring the book right up-to-date. Thus Harington's work on the structure of thyroxin, the active principle of the thyroid gland, is referred to, and a short but adequate account is given of the effect of insulin upon the normal organism. In this connexion the work of Best, Dale, Hoet, and Marks is mentioned. These authors have been able to show that the sugar which disappears from the blood under the action of insulin can be completely accounted for, either by combustion or by conversion into glycogen in the muscles.

Perhaps the two most useful chapters are that on the mechanism of postural reflexes and the functions of the labyrinth, in which an account is given of the work of Magnus, and the one on conditioned reflexes, describing the methods of research and the results obtained by the Russian physiologist, Pavlov. In neither case is there any adequate summary of this most important work extant in the English tongue. Perhaps the least satisfactory chapter is that on the physical aspects of the physiology of muscular contraction, which might be made clearer by a fuller description of elementary principles. On the other hand, the author is quite at home in the chapters on the blood, especially in that dealing with its reaction. Alto-

gether, this is a most interesting book, and can be thoroughly recommended to all interested in the subject of physiology.

Die Enzyme: Wirkungen und Eigenschaften. Von Ernst Waldschmidt-Leitz. (Die Wissenschaft: Sammlung von Einzeldarstellungen aus den Gebieten der Naturwissenschaften und der Technik, Band 76.) Pp. xvi + 233. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 14 gold marks.

THE object of the author of this short and excellent account of the enzymes is to illustrate the general principles of enzyme action and the results of recent work on the separation and the partial purification of enzymes by a series of examples, rather than to attempt a complete account of the subject. Accordingly the first hundred pages deal with general matters, the remainder of the book being devoted to a brief consideration of the various groups of enzymes.

The close association of the author with the recent work of Willstätter (to whom the book is dedicated) adds interest and authority to his fascinating account of the methods of preparative enzyme chemistry. The quantitative measurement of enzyme action is here seen to be essential for all true progress in our knowledge of the nature of enzymes. On this fundamental question the author supports the conception of Willstätter that enzymes are definite and separable chemical individuals, probably consisting of a colloidal 'carrier' and a specifically active group.

The book is written in a clear and interesting manner, is well up-to-date, and is provided with a good index and sufficient references. A. H.

Soil Characteristics: a Field and Laboratory Guide. By Prof. Paul Emerson. Pp. x + 222. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 12s. 6d. net.

METHODS of soil investigation are now so numerous and varied that a volume including some description of the more important of these fills a definite gap. The features of special soil types are not dealt with, but as a preliminary the procedures adopted in soil surveying and sampling are outlined, together with methods of classification and mechanical analyses. Analytical methods for the determination of various soil constituents are given in detail, special attention being devoted to the preparation of equipment. The physics and biology of the soil are not dealt with so fully, but sufficient is given to direct the attention of the student to the main aspects of the problems involved.

The bibliographies are conveniently placed at the end of the various sections, but consist mainly of references to American papers. Numerous laboratory experiments are suggested and outlined wherever possible, with the intention of supplying training on a good working basis for the determination of the characteristics of whatever soils may come under consideration.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Recession of the Tahitian Coral Reefs.

It is generally assumed that coral reefs are still growing, and when the outer slope is fairly well covered with living corals there seems to be no doubt about the matter. Yet in Tahiti and the adjacent island of Moorea there is no doubt that even with a fair abundance of living coral, the reefs are slowly going back.

Pending the publication of a full account, the following are evidences for this unexpected conclusion:

(1) The form of the outer slope, its regularity and smoothness, absence of all sand and debris—down to 10 or 12 fathoms it is absolutely clean.

(2) Its being cut into by trenches at short intervals. These are very clearly under erosion, their vertical sides and flat bottoms being scoured clean of every growth. These extend from where the surf breaks just under the raised edge of the reef to 10 fathoms, where they open out on to the general slope. For the lower 7 or 8 fathoms of their course they lie at the bottom of ravines the sides of which are covered with corals to exactly the same extent as the open slopes, but for all that, growth has not sufficed to make the ravine's sides vertical or anywhere near that. These trenches are not in the least like out-growing tongues or buttresses; they do not resemble at all those described and mapped in the Report on Funafuti, for example.

(3) The strong scour on these slopes is shown also by the fact that it is the corymbose *Madreporas* (*Acropora*), which are the dominant corals, this form of growth being a special modification for the purpose of raising the colony above the fatal sand rasp of the bottom. This became clear to me from my experiments with pearl oysters in the Red Sea. These corals are all, as it were, planted out at intervals of a foot or two over the surface, never riotously crowded as on the reefs of the Red Sea or the lagoon reefs of Tahiti.

(4) Coral growth ends quite definitely at from 10 to 12 fathoms down, instead of the usual 30 fathoms or more.

(5) The final and conclusive proof is that some of the stones which lie in the trenches are rounded pieces of basalt from the hills. One finds such stones at intervals on any part of the reef, on both sides of the lagoon, either lying on the eroded outer flat or bedded into the vertical walls of the shoreward lagoon reefs. It is clear that the reef was originally continuous from shore to edge, and that the lagoon is a comparatively recent secondary formation. The stones on the outer slope would have been buried deeply in coral if there had been any extension of the reef seawards since the opening of the lagoons cut off the supply from the island. They prove more than that growth has come to a standstill since that event, for the stones could not lie on this slope for long; they must in time be swept downwards. Those now in view have been exposed comparatively recently by the erosion of the coral in which they were embedded.

(6) Though there is no coral rock in all Tahiti raised above sea-level so high as to be dry land, there

is in three places in Moorea. (One of these was reported as coral to Capt. Cook by his officers, but Agassiz was so badly served as to be told that the rock was volcanic.) All three are on the outer sides of islets of coral sand on the reefs, and near the outer edge, and all were originally the outer shallow part of the lagoon floor, which is now two feet above water-level and in an extraordinarily perfect state of preservation. Their position so near the present reef-edge affords another proof that there has been no extension seawards since that lowering of the ocean surface which left these lagoon floors dry, and exposed the shelves along the foot of cliffs in so many islands of the Pacific, the Marquesan and Society Islands included.

(7) Unlike the other islands of the group, Tahiti is not completely surrounded by a 'barrier' reef. (The reason for the use of inverted commas is given above.) There are no surface reefs for miles off the north-eastern corner of the island, but soundings show that the reefs are there, but under about 5 fathoms of water. These might be (1) reefs growing up which have not yet reached the surface; (2) reefs submerged by local subsidence, but the chart itself shows clearly that they are not; (3) parts of an original shelf upon which all the reefs were founded. The examination of the shores within them shows that there was once the usual maritime flat here as round the rest of the island, which has now disappeared, leaving relics here and there to show its former existence, and the comparison of the reefs themselves with those which reach the surface shows that they are exactly the same but for the removal of the upper five fathoms or so.

I find it difficult to account for this reduction in the vigour of coral growth, but one factor has probably been the laterisation of basalt, its conversion from hard rock to that red clay so conspicuous on the slopes, which in floods causes all the streams to run red. This does not, however, seem possible as the whole explanation, and there may be biological changes involved, such as in the species of coral dominant, the balance between the organisms which build and those which destroy reef material, or even in coral physiology.

In Tahiti and Moorea, at any rate, it is clear that the age of corals is past. Is it possible that this is true of the world in general? In 1902 the writer showed that the great reef of tropical East Africa is nothing but a shelf cut by the sea into the great mass of raised coral which forms these coasts; in the Red Sea, part of the breadth of the reefs is formed in the same way and part by the growth which has occurred since the elevation, but where the distinction can be made out the latter is comparatively small. In reading most descriptions of reefs one is struck by the disproportion between the amount of growing material present now and the huge structure raised by growth in the past.

The possibility that the latest of the coral ages is now passing or passed, introduces another complication into this ever-fascinating study, and the possibility of former extensions of the present surface reefs is one to be borne in mind in future investigations.

I desire to acknowledge the assistance received from the Government's Grant Committee of the Royal Society and the managers of the Balfour Fund of this University, which made possible the exploration of which this is the more important result.

CYRIL CROSSLAND.

The Zoological Laboratory,
Cambridge,
Mar. 3.

Advantages of the Ring Method for the Study of the Surface Equilibria of Colloidal Solutions.

THE letter of Prof. Harkins, concerning some of the methods used for measuring surface tension,¹ contains a statement about the ring method which may mislead the reader; and the addition of a few words to it may therefore be worth while.

My efforts in the past five years have tended to emphasise the importance of a phenomenon which had been overlooked so far, namely, the decrease in the surface tension of colloidal solutions as a function of the time. Although a few exceptions have been found, the great majority of colloidal solutions obey this law, including dyes, proteins, metallic sols, gums, etc. It was known that the static value of the surface tension was different from the dynamic value, but it was generally agreed that the adsorption in the surface layer took place almost instantaneously.²

The study of the delayed adsorption, which can be followed step by step over periods of hours through the consequent decrease in the surface tension, can obviously only be observed by using a method permitting a proper control of the time. As the surface tension of a colloid solution begins to decrease as soon as it is no longer stirred, its value depends on the time elapsed since the last stirring. By using the instrument which I call for short a 'tensiometer,' according to a technique first described in 1922 and improved in 1925,³ it was possible to obtain the values of the surface tension about 1/10 of a second after the stirring. These values, for sodium oleate solutions diluted to 1/25,000, were only slightly less than the value of the surface tension of pure water, namely, 68 to 69 dynes at 20° C. Measurements taken at ten seconds' interval showed the decrease which, under the conditions of the experiments (2 c.c. in watch-glasses), took place proportionally to the time. After thirty seconds the value was 55 dynes, and after one minute, 42 dynes. The curve expressing the decrease then assumed a logarithmic shape, and the static value was attained, in this case in five minutes, at 36.6 dynes. At higher dilutions, the time required to reach the static value is greater; for example, at 1/100,000 under the same experimental conditions, the static value was equal to 32.1 dynes and was reached in twelve minutes. It is obvious that the time required to reach the equilibrium depends on three main factors: concentration, mobility of molecules (function

of the viscosity of the solution), and ratio $\frac{\text{surface}}{\text{volume}}$ of the container. It may vary with different solutions in watch-glasses (2 c.c.) from twenty minutes (pure serum) to three hours or more (serum diluted 10,000 to 20,000 times).

Such measurements are very easy and simple to perform with good accuracy by means of the tensiometer. If a drop method, even though highly improved, were used, it would require waiting two or three hours, sometimes more, for every drop to form and fall. If it be assumed that three drops were sufficient to obtain a satisfactory accuracy, which is an optimistic view to say the least, this would mean, with one instrument, six hours instead of two, or nine hours instead of three, and an accurate control of this time would be exceedingly difficult. The determination of a complete adsorption isotherm would require days. Moreover, the estimation of the total adsorbing area, which is an important factor,

would not be an easy matter and would involve the calculation of the surface of the drop itself. I have shown⁴ that under certain conditions absolute minima of the value of the surface tension are observed at very high dilutions (at 1/750,000, 1/1,220,000, and 1/1,390,000 in the case of 2 c.c. of sodium oleate in watch-glasses), and that these minima can be shifted by altering the area of the adsorbing surfaces (by adding glass beads, for example). The hanging-drop method does not readily lend itself to such experiments.

Another interesting phenomenon was described in 1922,⁵ namely, the 'antagonistic action' of one colloid upon another. When a strongly surface-active substance, such as sodium oleate, is added to a solution of colloids with larger molecules or particles (proteins, metallic sols), a sudden drop in the surface tension is observed, as would be expected, but this drop is immediately followed by a rapid rise which can be followed step by step with the tensiometer, and, under certain conditions, the original surface tension is reached after seven minutes. When measurements are made every thirty seconds, a perfect adsorption isotherm is obtained.⁶ It is doubtful whether this phenomenon could be studied at all with any drop-weight method. Yet it is important, since it gives a method whereby adsorption may be studied quantitatively with great ease and rapidity, and whereby the area of adsorbing surfaces may be evaluated. This problem is being investigated at present in our laboratory.

A slight modification of the tensiometer makes it possible to measure interfacial tensions.⁷ With this instrument we have obtained adsorption isotherms at the interface between paraffin oil and sodium oleate solutions, as a function of time;⁸ the action of temperature at the interface between water and ethyl ether and water-carbon disulphide was also investigated with great facility, and gave positive temperature coefficients.

I have mentioned a few of the results which were found as a direct consequence of the use of the ring method improved so as to render it practical and very rapid. In the biological field this method has enabled us to study the processes of immunity in animals, and to reach certain conclusions which are not devoid of interest. On the other hand, the absolute value of the surface tension of water obtained without any correction with the du Noüy tensiometer agrees within ± 0.1 dyne with the values published by the best authors (72.6 dynes at 18° C.). Furthermore, although criticised by some, the ring method has nevertheless in recent years aroused so much interest that Prof. Harkins himself, whose authority in this field is unchallenged, has found it necessary to give it a great deal of attention, and leads us to hope that he and his collaborators will soon be able to give a corrected formula which will reduce the errors to less than 0.1 per cent. This correction, although uncalled for in the case of water and most aqueous solutions, will undoubtedly establish the superiority of the ring method over all others, so far as convenience, rapidity, reliability, and adaptability to different problems are concerned. I trust I have made it clear that it has already scored in the particular case of colloids.

P. LECOMTE DU NOÛY.

Rockefeller Institute for
Medical Research.

¹ P. L. du Noüy, *Phil. Mag.*, 1924, 48, 664; "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 86 and fol.

² P. L. du Noüy, *J. Exp. Med.*, 1922, 36, 115.

³ P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 155 and fol.

⁴ P. L. du Noüy, *J. Gen. Physiol.*, 1925, 7, 625.

⁵ P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 174 and fol.

¹ W. D. Harkins, *NATURE*, Nov. 20, 1926, p. 732.

² W. M. Bayliss, "Principles of General Physiology" (London, 1918), p. 56. H. Freundlich, "Capillary Chemistry" (New York, 1926), pp. 50-52.

³ P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids," *Ann. Chem. Soc. Monographs* (New York, 1926).

Efficiency or Effectivity?

ONE of the most difficult problems which confronts all investigators who have to deal with man as a worker, is the assessment of his fitness to produce. The accurate determination of the degree of fitness of the man to perform his work has never been satisfactorily elucidated, so that reliance is placed most frequently on the measure of his productiveness as shown, say, by the number of articles produced, the quality of his work, the time taken to perform selected operations, alterations in skill of performance, etc. Further, when it is desired to refer to any alteration, either by way of enhancement or diminution, in the individual's capacity to carry on any particular operation, it is generally said that the man's *efficiency* is increased or diminished.

It is true that modern usage, as indicated by the "New English Dictionary," for example, authorises a definition of the word *efficiency* as "fitness or power to accomplish, or success in accomplishing, the purpose intended"; and as another meaning it gives "efficient powers or capacities." Colloquially the word *efficiency* is commonly used, with perhaps even wider significance, as a synonym for power to perform, for the conduct of business with energy and with the minimum of waste, not only on the part of single individuals but also of groups of workers.

It has, of course, long been recognised that the term *efficiency* is neither a scientific nor, in the light of modern knowledge, an apt one by which to refer to the individual's change in capacity. The engineer has appropriated to his own technical vocabulary a word which had long been in common use, and as a result it has come to have a very definite connotation in engineering, and even in physiological, science. When used by the engineer it is, as a rule, qualified by some adjective indicative of the particular type of efficiency to which he is referring. Thus he may speak of mechanical or thermal or thermodynamic efficiency.

The physiologist, too, has investigated the efficiency—in the engineering sense it would be the over-all thermal efficiency—of the human body and has arrived at very definite results. While it is open to question whether a mode of calculation suitable in the case of the development of energy in a mechanical apparatus, like a steam engine, is applicable to the series of metabolic processes common to the human body, where, it must be remembered, food serves not only for yielding energy but also for the repair of tissue waste, no serious objection can perhaps be taken, provided the limitations of the method are kept in mind.

As an alternative to the displacement of the term *efficiency* from the engineer's vocabulary, a feat which would be practically impossible of accomplishment, we must be prepared either to use the word with a double significance or else find a substitute. It is clear that the common usage of the term in connexion with everyday labour of all kinds cannot be justified. We have no right to refer to the increased or diminished efficiency with which a man performs a specific piece of work if we, at the same time, take no cognisance of the data which must be determined before the actual efficiency of production may be considered. The use of the word *efficiency* is then simply a loose colloquial way of referring to a general condition of human well-being with absolutely no reference whatsoever to the true scientific meaning of the term.

When we speak of efficiency in this general way, what we want to express is, that the individual in question is performing his work in the most effective and useful fashion. In other words, the idea we wish to convey has nothing to do with that other determinable factor involved in man's productive powers,

namely, the ratio of his energy expenditure in the form of useful work to his intake of energy or to his total expenditure of energy, but simply with the degree of effectiveness with which the work is done.

In view, then, of the confusion of ideas which must arise when the same word is employed to define two very different types of phenomena in man, it is suggested that it would be best to employ two words. Let the word *efficiency* be confined, whether fully justified or no, to the ratio of the energy exchange in the performance of work, but in order to cover the much wider field, where there are no special but innumerable general physiological or physical determinants, and where we wish to speak of enhanced or diminished capacity to perform, it is suggested that a word like *effectivity* might be more fitly employed. Such a word commits us to no underlying single series of physiological phenomena, but is perfectly general, and refers merely to the sum total of the factors which lead to effective production, and it can therefore be suitably applied to a wide range of activities of individuals or groups of individuals. The word has been selected as the most suitable from a number of alternatives, all, more or less, expressing the same general idea.

As a practical illustration of the difference between "efficiency" and "effectivity" one of the experiments which I published in conjunction with Prof. F. G. Benedict may be cited. We determined the efficiency of a highly trained subject doing most strenuous work on a bicycle ergometer for more than 4 hours. His efficiency at the start was 23.1 per cent., and in the observation made just before the experiment ended, due to the impending collapse of the subject, it was 21.3 per cent. One can state, then, in this extreme example, that although there was but a small reduction in the subject's efficiency, his effectivity at the end was nil.

It may be remarked in conclusion that certain of the German workers have found the same difficulty, but, so far as I am aware, none of them has suggested a term to cover the idea which it is desired to express. Effectivity, if it find acceptance, might be utilised by German workers as 'Effektivität.'

E. P. CATHCART.

The University,
Glasgow.

The Mechanism of the so-called 'Posterior Sucker' of a Simulium Larva.

THE manner in which a Simulium larva fixes itself to rocks and water weeds in very rapid running water has hitherto been a matter of dispute among naturalists. Some have supposed that the so-called 'posterior sucker' of a Simulium larva functions in the same way as does the sucker of a leech, and it is only recently that Tonnoir (*Ann. Biol. Lacustre*, 11, pp. 163-172; 1923), not finding any muscles inserted in the middle of the disc, doubted its utility as a true sucker and ascribed the function of attachment to the hooks alone. Dr. Puri (*Parasitology*, 17, pp. 295-369; 1925), to whom we are indebted for a monograph, "On the Life-history and Structure of the Early Stages of Simuliidæ" (1925), has demonstrated the presence of fairly strong muscles connected with the centre of the disc, and he has observed "that they contract when the larva fixes itself by its posterior end." But he further points out that "in spite of the presence of these muscles the larva cannot fix itself effectively without the further help of the sticky salivary secretion; a fact which may mean that the saliva helps to fill up the spaces between the hooks and thus to form a complete rim all round."

In determining the function of the 'posterior sucker' it seems to me that undue importance has been attached to the presence or absence of muscles in the centre of the disc.

Recently, while preparing a public lecture for the fourteenth annual meeting of the Indian Science Congress at Lahore, on "Animal Life in Torrential Streams," I made a number of observations on many kinds of animals living in swift currents. An entire week was devoted to the study of *Simulium* larvæ,

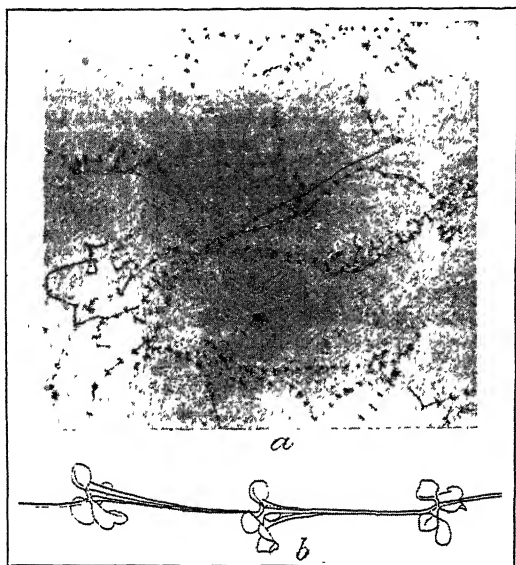


FIG. 1.—Tracks of sticky salivary secretion left by *Simulium* larvæ on a glass slide. *a*, Photograph of the tracks; *b*, a portion of the same much enlarged.

which I found in great abundance both on the water plant *Eriocaulon miserum* Kaern., and on bare rocks in a small stream below the Dumpep Bungalow in the Khasi Hills. A close study of the habits of these larvæ has led me to conclude that the posterior appendage does not act as a sucker, but fixes itself with the help of hooks alone. These are capable of gripping firmly a cluster of silk threads (the sticky salivary secretion) which the animal secretes on the spot where it intends the posterior appendage to be fixed. The presence of strong muscles in connexion with this appendage is necessary, for, in order to disengage the hooks from the salivary secretion, a strong and sudden muscular pull is required. This action is readily noticed when a larva, moving from one place to another, is examined under water. The muscular action noticed by Dr. Puri at the time of attachment of the sucker is a manipulation on the part of the animal to enable it to fix its hooks effectively in the secretion.

If a larva is allowed to crawl about on a slide, it is noticed that the progression is effected by the help of the thoracic proleg and the salivary secretion. A small amount of the salivary secretion is poured out and the hooks on the proleg grapple on to it. The larva goes on pouring out a thread of saliva as it progresses. A number of these larvæ were allowed to crawl about on a slide and the method of their progression was beautifully illustrated by the track of the secretion they left behind them (Fig. 1).

SUNDER LAL HORA.

Indian Museum, Calcutta,
Jan. 19.

No. 2999, Vol. 119]

The Formation of Twin Metallic Crystals.

IN the discussion in NATURE (Jan. 22, p. 120, and Mar. 12, p. 392), Mr. McKeehan has taken exception to statements of Carpenter and Tamura in a paper on the above subject on the grounds that the method of formation of twins depicted by them brings atom centres too close together. Twinning by reflection about a plane is considered, and the discussion hinges on the precise location of this plane with reference to the planes of atoms. Geometrically, a twin crystal of this type consists of two individuals united symmetrically about a plane, which is not one of systematic symmetry but is a possible crystal face (Tutton, "Crystallography and Practical Crystal Measurement," 2nd ed. vol. 1, p. 500, where it is also stated that the plane of twinning is "usually one with low indices and indeed very often a primary face"). In view of the improbably small distance of approach of atoms required by Carpenter and Tamura's hypotheses, it appeared to be worth while examining the effect of adding to the above geometrical law of twinning the *physical* conditions (1) that the reflection plane can only be one such that the operation of twinning does not bring atom centres closer to one another than the closest distance of approach of atoms in either component of the twin, and (2) that the components of the twin have in common at least one plane of atoms. Briefly, these conditions imply minimum stress and maximum continuity of structure.

Subject to these assumptions, it may be shown that for a simple cubic lattice, twinning of the type considered can only take place about $\{100\}$, $\{110\}$, $\{111\}$ or $\{200\}$, of which the first two and the last are systematic planes of symmetry and lead only to cases of parallel growth in holohedral forms. For a body-centred cube such as α -iron there is no plane, other than $\{100\}$, $\{110\}$, $\{200\}$, which fulfils condition (1), but $\{211\}$ requires a very small compression and might be permissible. For a face-centred cube, $\{111\}$ is the only plane other than $\{100\}$, $\{110\}$, $\{200\}$ and $\{220\}$. In the case of the diamond structure the only plane other than symmetry planes is that mentioned by Mr. McKeehan (NATURE, Jan. 22), namely, a plane parallel to $\{111\}$ cutting the cube diagonal at a distance $\frac{1}{3}$ th of its length from the origin and bisecting a line joining two atoms which are separated by the closest distance of approach—the co-ordinates of the atoms being $000, 0\frac{1}{2}, 0\frac{1}{2}, 0\frac{1}{2}$. In this structure the components of the twin have two planes of atoms in common, and the reflecting plane lies midway between them.

So far as the metals which crystallise on a face-centred cubic lattice are concerned, the above results seem to be correct. Gold, silver, copper, lead, platinum, and iridium are stated by Dana to twin about $\{111\}$. Diamond and silicon also twin on this plane. Iron is stated to twin on $\{111\}$, contrary to the result obtained above; but as this material passes through a transformation in cooling, the existence of twinning in the α -modification would have to be confirmed by X-ray measurements. I understand that twins are rarely, if ever, observed in the body-centred cubic metals.

The application of the above hypothesis to the case of compounds is too complicated to be dealt with here; but sodium chloride and potassium chloride, in which the atoms are situated at the corners of a simple cube, ought to twin on $\{111\}$, as they are in fact observed to do (Groth). The case of calcite can be derived from this, for when the sodium and chlorine atoms are replaced by calcium and carbon respectively and the cube distorted to a

rhomb, $\{100\}$ becomes a possible twin plane and is commonly observed. In general each case would have to be considered separately in conjunction with a knowledge of the structure obtained by X-rays.

G. D. PRESTON.

The National Physical Laboratory,
Teddington, Middlesex,
Mar. 16.

X-ray Diffraction in Liquids.

In order to find experimental support for the theory of X-ray diffraction in liquids put forward some three years ago by C. V. Raman and K. R. Ramanathan (*Proc. Indian Association for the Cultivation of Science*, vol. 8, p. 127, 1923), extensive studies have been undertaken in the authors' laboratory of the phenomena observed when a pencil of monochromatic X-rays passes through a layer of fluid, particularly with the view of determining how the effects are influenced by the physical condition and the chemical nature of the substance under investigation. The

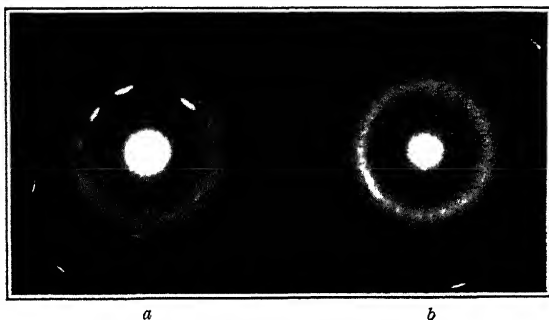


FIG. 1.—X-ray diffraction haloes of liquids.
a, Hexane; b, cyclo-hexane.

photographs here reproduced (Fig. 1, a and b) were obtained in the course of work on this line by one of us (C. M. Sogani) and represent the X-ray liquid-haloes of hexane and cyclo-hexane respectively. The fluids were contained in cells with very thin walls of mica, and the K-radiation of copper from a Shearer X-ray tube was used.

The differences between the two patterns are sufficiently striking; cyclo-hexane shows a bright and sharply defined halo with a very clear dark space within, while hexane, on the other hand, shows a less intense and relatively diffuse halo, the inner margin of which is not sharply terminated but extends almost up to the direction of the incident rays. These differences indicate very clearly the effect of the geometrical form of the molecules on the X-ray scattering by a liquid. From an X-ray point of view, cyclo-hexane consisting of ring-formed—though arbitrarily orientated—molecules has a nearly homogeneous structure, while on the other hand the elongated shape and varying orientations of the molecules in hexane cause it to be much less homogeneous in X-ray scattering. This explanation is supported by the observation that the diffraction halo of benzene resembles very closely that of cyclo-hexane.

It is very interesting to contrast these facts with the optical behaviour of the three liquids with regard to the scattering of ordinary light. Optically, hexane and cyclo-hexane are far more nearly similar to each other, and differ strikingly from benzene, the depolarisation of the scattered light being small for hexane and cyclo-hexane and relatively large for benzene. Here, evidently, the geometrical form of the molecule is of much less importance than its chemical character.

Further studies of the liquid-haloes for various organic substances of the aromatic and aliphatic series, and specially with the long-chain compounds, are in progress.

C. V. RAMAN.
C. M. SOGANI.

210 Bowbazar Street,
Calcutta, India, Feb. 10.

Prehistoric Archaeology in Yorkshire.

It is difficult to see what connexion there is between the East Riding Antiquarian Society forming an outdoor museum in the Old Tithe Barn at Easington, Yorkshire, and the fact that the Hull Corporation has the Mortimer collection of prehistoric antiquities in its possession, though not on proper exhibition (*NATURE*, April 2, p. 494).

The Tithe Barn at Easington has been handed over to the East Riding Antiquarian Society by the Ecclesiastical Commissioners, and the Society is taking the responsibility of its restoration and preservation, and is converting it into a museum of old farming appliances, at its own cost. The only part the Hull Corporation is playing in the matter is that it is permitting its Museum Director to select such objects as are likely to be suitable for exhibition, and placing them in the Tithe Barn, where they will be in much more appropriate surroundings, while the space in the other Corporation museums which they now occupy can be more suitably utilised.

The case against the Hull Corporation is scarcely so black as Mr. Crawford paints it. Certainly the Mortimer collection was purchased from the family, on advantageous terms, and the money given for its purchase to the Hull Corporation by Colonel G. H. Clarke, who stipulated that so important a collection should not be merged in any of the other museums, but should have a building to itself. This condition the Corporation accepted, and this condition Colonel Clarke quite properly is pressing the Corporation to fulfil. Unfortunately, soon after the purchase the War broke out, and as the Driffield Museum was likely to be wanted for military purposes, the collection had to be packed and removed to Hull, where a large house was rented for its reception. Afterwards this was required for other purposes, and the collection was again removed into a warehouse adjoining one of the museums. The matter of the proper accommodation of the collection has been brought up many times, but the conditions which obtained during the War and afterwards made building a separate museum a difficult proposition. However, at the present moment negotiations are on foot for the purchase of a large building in the centre of the city which will admirably answer the purpose, and personally I hope that this will be concluded.

It is scarcely correct, however, to say that the specimens are all in packing-cases. As a matter of fact, some little time ago the Corporation erected a special large workshop for the proper restoration, labelling, and display of the Mortimer collection, and also appointed a junior assistant whose whole time is occupied in the work. In addition, most of the important bronze age pottery, the bronzes and other more valuable specimens from the tumuli, are on temporary exhibition at the Albion Street Museum.

However, may I sincerely thank Mr. Crawford for writing his letter, as the matter has been taken up rather vigorously by the local press as a result, and I trust, now the attention of the Hull City Council has been directed to the matter, something tangible may accrue.

T. SHEPPARD
(Director.)

The Municipal Museums,
Hull, April 6.

Phytophagic or Biological Races in Insects.

MR. MEYRICK points out in his letter (NATURE, Mar. 12, p. 388) that the idea of biological races is by no means a new one, and, judging from his last paragraph, he seems to think that the principle may be of but little importance as a factor in the production of new species. It may not be out of place to direct attention to the fact that the phenomenon appears to be very widespread among the Insecta.

As regards the Lepidoptera, besides the cases mentioned by Mr. Meyrick, the Codlin moth (*Cydia pomonella*) (H. J. Quayle, 1926) is an interesting probable example observed in the United States; while on the experimental side the production by Pictet (1911) of an inherited modification of feeding habit in *Lasioampa quercus* is of much interest, although the results are by no means so conclusive as those of Dr. Harrison. The present writer is now working on moths of the genus *Hyponomeuta* from this point of view, and although the experiments are not yet sufficiently far advanced for publication, it seems that to postulate the existence of biological races adapted to special food plants offers the simplest explanation of the facts so far observed.

Among Rhynchota the capsid *Plesiocoris rugicollis* (Petherbridge and Husain, 1917) is another probable case, while in Homoptera the experimental work of P. Marchal (1908) on the coccid *Lecanium* offers a very close parallel to that of Dr. Harrison. In Diptera, to mention only one case, Cameron (1914) working on the anthomyid, *Pegomyia hyoscyami*, definitely proved the existence of at least two biologic strains within the one species.

Similar results have been obtained among Coleoptera, the best known being that of Schroeder (1903) on the *Salix* feeding beetle, *Phratora vitellinae*. This again showed a result very close to that of Dr. Harrison on *Pontania*.

The above are just a few of the more striking cases known, but enough has been said to show that the phenomenon is probably very widely spread among phytophagous insects and, as Mr. Meyrick justly remarks, can scarcely be described as a new principle. Possibly, however, it is of more importance in the evolution of new species than Mr. Meyrick appears to think.

In this connexion it is interesting to note that Dr. M. Hering in his recent book, "Biologie der Schmetterlinge" (1926), says: "Wir können also festhalten: Polyphag in der Raupe sind phyletisch alte Formen; Monophagie ist eine Erwerbung jüngeren Datums." If this generalisation is correct it would seem that phytophagic races may have been the means by which monophagous species were evolved.

W. H. THORPE.

Zoological Laboratory,
Cambridge.

The Geissler Discharge in Argon.

THERE is now a considerable literature dealing with analysis of arcs, and of glow discharges from a hot cathode, in which Langmuir's improved method of using an exploring electrode has been employed. It has been shown by one of us that, as would be expected, the same method can be applied to the glow discharge between cold electrodes (*Proc. Camb. Phil. Soc.*, 23, p. 531; 1927). This work was of a preliminary nature, and the results were, to a certain extent, ambiguous. We have now repeated the experiments under better conditions, in argon, and have confirmed the earlier results.

With a low current density and conditions not far different from those corresponding to a normal

cathode fall of potential, there is a sharp maximum in the concentrations of both positive ions and electrons at the middle of the negative glow. The electric field is reversed between this region and the edge of the cathode dark space, and two groups of fast electrons appear. There are here present electrons with energy corresponding to a large fraction of the full cathode fall of potential. The Faraday dark space extends almost to the anode, and the electric field in it is small at the higher pressures (0.8 mm.) and strongly reversed at the lower pressures (0.2 mm.). We find that the ionic concentration gradients are sufficient to carry the current by diffusion through the reversed electric field, as in low voltage arcs.

Our curves for the collector characteristic in the cathode dark space are difficult to analyse, and it may be questioned if any method of using an exploring electrode may legitimately be applied to this region of the discharge, because of the disturbance indicated by the 'shadows' thrown by the collector.

K. G. EMELETS.

N. L. HARRIS.

Wheatstone Laboratory,
King's College,
University of London, Mar. 14.

Relation between the Reciprocal Impenetrability of Matter and Pauli's Exclusion Principle: A Correction.

SOME paradoxes which have occurred to me and have been pointed out to me also by some of my colleagues (especially Dr. Fues, Copenhagen), show that the fundamental statement of my letter (NATURE, Feb. 5) published under the above title, is incorrect. It is not true that the reciprocal impenetrability of the molecules allows only of the Heisenberg-Dirac determinant solutions, and excludes all others. On the contrary, *all* the symmetrical and antisymmetrical characteristic solutions which existed for absolutely penetrable molecules remain for a (not one-dimensional) gas with molecules having a radius very small compared with the mean distance; only the characteristic values are a little changed, and the characteristic functions undergo a deformation in the immediate neighbourhood of the 'diagonal spaces.' If, therefore, the Pauli principle is valid not only for the electrons of an atom but also for the translatory motion of gas molecules, with radius almost zero, then such a remarkable relation between the molecules cannot be so simply explained by wave mechanics as my mistake led me to believe.

P. EHRENFEST.

The Property of Dilatancy.

THE theory of dilatancy, the characteristic of the deformation of granular materials, was given by Osborne Reynolds before the Aberdeen meeting of the British Association on Sept. 10 and 15, 1885, and later in a modified form before the Royal Institution, Feb. 12, 1886. These presentations were published in the *Phil. Mag.*, vol. 20, pp. 469-481, 1885, and in NATURE, vol. 33, pp. 429-430, 1886, and later in Reynolds's collected papers.

Since then there has apparently been little discussion of the phenomenon, and the few references I have were found accidentally in papers bearing no hint in their title of a discussion of this subject.

I shall be grateful to any one who will furnish me with references to papers in which the phenomenon is discussed.

L. B. TUCKERMAN.

Bureau of Standards,
Washington, Mar. 12.

The Acoustics of Buildings.¹

By Dr. G. W. C. KAYE.

IN view of the examples of acoustically defective halls which abound in our towns and cities, it is the more surprising to find that the fundamental principles of architectural acoustics were clearly appreciated nearly a century ago in Great Britain by a number of workers. Then, as now, it was realised that the two defects most frequently met with in large auditoriums are (1) echoes and (2) excess of reverberation; that is, the tendency of an arrested sound to persist unduly by multiple reflection at the boundaries, owing to their deficient absorptive properties.

So long ago as 1835, at a meeting of the British Association at Dublin, we find Reid recognising reverberation as a prevalent acoustic defect and suggesting remedies in the shape of more absorbent walls by increasing their roughness or irregularity, or by hanging draperies. He also stressed the advantage of excluding superfluous space.

Dickens's acoustic powers of observation are exemplified in "Martin Chuzzlewit," written in 1843. In Chap. ix., in describing the houses in the neighbourhood of Todger's boarding-house, he relates how

"these mansions, now only used for storehouses, were dark and dull, and, being filled with wool, and cotton, and the like—such heavy merchandise as stifles sound and stops the throat of echo—had an air of palpable deadness about them."

Roger Smith, in his "Acoustics of Public Buildings" (1861), remarked that: "In empty houses a great reverberation is perceptible which diminishes as the floors are covered with carpets and the rooms filled with furniture." Tyndall, in 1868, in evidence before a Select Committee of the House of Commons, stressed the value of a low ceiling as a reinforcing device, and the influence of an audience and of draperies in quenching the after-sound. During the proceedings of this committee, it was elicited that flock paper applied to the walls of a reverberant room had proved an effective remedy.

Again, Johnstone Stoney (1885) described how he tested a room which had its walls papered over a lining of canvas, the canvas being a short distance in front of the framework over which it was stretched. From his experiment he inferred that concert halls or public rooms could be effectually freed from echo effects by the simple expedient of lining the walls and ceiling in such a manner.

Rayleigh, in the second edition of his "Theory of Sound" (1896), gave the first mathematical treatment of the absorption of sound waves by porous rigid bodies. He clearly recognised the inevitability of reverberation in large rooms with non-porous boundaries, and suggested a remedy in the shape of thick carpets, curtains, etc.

The ground would seem to have been well prepared for a systematic investigation on audi-

torium acoustics in England, but it was not forthcoming, and it is to the pioneer work of the late Prof. W. C. Sabine, of Harvard University, that we must turn for the first elucidation of the main practical problems, particularly as regards reverberation. His "Collected Papers on Acoustics" extend over the period from 1900 to 1915, and his work and that of others has attracted considerable attention both in the United States and Germany.

As a consequence, although much remains to be done, there is now sufficient volume of experience to enable the main acoustic requirements of a building to be satisfactorily met before the erection of the building is even commenced.

The principles are simple and straightforward, but much scepticism and apathy will have to be dispelled in Great Britain to prevent a repetition of the acoustical failures conspicuous in a number of modern halls. The Press reflects the view commonly held that architectural acoustics is a gamble. For example, the *Times* on July 24, 1922, remarked that: "Broadly speaking, it may be said that the acoustic qualities of a hall or room cannot yet be predicted"; and again in its issue of Oct. 19, 1926, it was stated that "there is no means of studying the acoustic properties of a building which does not exist, or exists only on paper."

However, within recent years the subject of applied acoustics, as a quantitative science, has become the object of study at a number of centres in England, notably the Signals Experimental Establishment at Woolwich, the National Physical Laboratory at Teddington, and the Building Research Station at Watford.

We may proceed to review some of the acoustical characteristics of a building.

ECHOES.

As regards echoes, it is found that an echo becomes noticeable when the reflected sound lags behind the direct sound by more than about $\frac{1}{15}$ second. If the lag is less than this, the reflected sound will serve to reinforce the direct sound. This is an argument in favour of limiting the heights of the ceilings of council chambers and the like to not more than about 35 ft., as the ceiling is the only reinforcer common to every speaker no matter what his location. The House of Commons serves as an illustration.

Thus the question of echoes will not arise except with large halls, though even a slight echo may contribute to poor hearing. The effect is not likely to be pronounced in the absence of smooth concave surfaces, such as a dome or barrel vaulting, which lead to uneven sound distribution and are definitely inimical to good acoustics. Such surfaces should be broken up, for example, by coffering, and the objectionable reflections absorbed by suitable means. A satisfactory distribution of sound may normally be anticipated within a hall of approximately rectangular section. Furthermore, inter-

¹ Abstracted from three Tyndall Lectures delivered at the Royal Institution in November 1926.

ference phenomena are not likely to be of any moment, particularly in the case of speech.

The reflecting characteristics of the boundaries of an auditorium may, with a little experience, be approximately appraised from a geometrical study of sections based upon the optical laws of reflection. Two other methods are available for use with scale-models. In one, first used by Sabine in this connexion in 1913, the progress of an actual sound-pulse in the model is displayed by the well-known method of spark illumination. In the other, use is

Fig. 1, taken at the National Physical Laboratory by Mr. Fleming, shows the progress of a sound-pulse in a central vertical section of the theatre of the Royal Institution, which was erected in 1800 and is of acknowledged acoustical excellence—a view subscribed to by Faraday in evidence before a Select Committee in 1835. In the figure, arrows drawn from the position of the source show the tracks of certain selected wave fronts.

REVERBERATION.

As already remarked, the common defect of large auditoriums is undue reverberation. Rigid non-porous walls have, on Rayleigh's estimate, a higher reflecting power for sound than the best mirrors have for light. Thus, unless absorptive materials in some form are provided, the rate of dying away of a sound in a large hall will normally be so protracted as to cause confusing overlapping of successive sounds or syllables emitted at ordinary rates.

It was primarily the work of Sabine that has made it possible to measure the proportion of incident sound energy absorbed by a material (that is, the absorbing power), or to predetermine the amount of absorbent necessary to ensure acceptable reverberation in a hall. If a steady source of sound in a room is suddenly stopped, then Sabine showed that the duration of audibility (when determined under proper conditions) is an important acoustical characteristic of the room. He established the relation that this reverberation period (as it is called) is proportional to the volume of the room, and inversely proportional to the total absorbing power of the boundaries and contents. If we work in square feet and seconds, the constant of proportionality is $\frac{1}{20}$. It may be noted that the relative linear dimensions of a room are not now regarded as material, except perhaps for extreme shapes.

The degree of reverberation is all-important. A certain amount is pleasing and helpful; excess leads to greater loudness but increased confusion; insufficient results in enfeeblement and staccato effects which are displeasing to hearers and, furthermore, impart a sense of deadness or absence of power to a speaker or singer. A great variety of observations have been carried out on the optimum reverberation periods to suit different conditions. Briefly, it may be said that for speech in relatively small halls (up to, say, 50,000 cubic feet) a period of about one second is preferred, the value increasing up to about two seconds for the largest halls. Cultivated musical opinion agrees in preferring rather longer periods for music, depending on its character and volume.

It may be remarked that in large cathedrals and churches, reverberation periods up to six or seven or more seconds are common, a condition which dates back to medieval times and is responsible for certain features of the services—the characteristic choral and organ music, the intoned liturgy, and the frequent inaudibility of the speaking voice.

The remedy for excessive reverberation in a

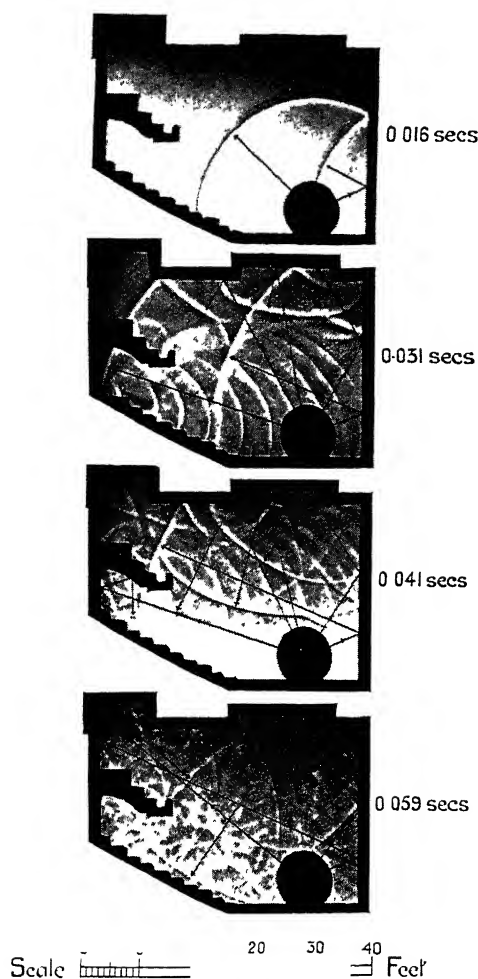


FIG. 1.—Sound-pulse study of the lecture theatre at the Royal Institution.

made of the analogy between water ripples and cylindrical sound waves, a method which appears to have been first suggested by Scott Russell at a meeting of the British Association in 1843. Each method has its advantages, and both give results which, although predictable in the main by geometrical methods, show also the spreading of waves by diffraction beyond the optical limits. Incidentally, either of the experimental methods is more convincing than the geometrical when for any reason it is desired to provide ocular demonstration of the acoustic properties of a particular architectural design.

room is either to reduce the volume, if practicable, say, by lowering the ceiling and partitioning off unnecessary large recesses, or to increase the sound-absorbing power of its surfaces by the use of absorbents such as felt, quilting, wood-wool, aerated plaster, fibre board, carpets, curtains, upholstery, etc. In some cases the disposition and shape of such absorbents can be so chosen that they will also serve to suppress undesirable reflections.

In passing, it may be added that there does not appear to be any recorded scientific evidence that stretched wires exert any beneficial effect in auditorium acoustics, though examples may still be found.

LOUDNESS.

In addition to the defects of echo and reverberation, the question of inadequate loudness will almost certainly arise in a large building, particularly in the case of speech. Experience agrees that the range of the unassisted speaking voice of average strength is of the order of 50 feet, that is, provided the hearer is so situated as to receive a direct 'ray' of sound. At greater distances it becomes necessary to provide reinforcement, either by reflection from suitable surfaces, or by an electrical loud-speaker system. In view of the increasing use that is being made of public address systems, it should be realised that their main office in a large hall is to provide adequate loudness in the remoter parts. Further, by placing the loud-speakers in suitably high positions, troublesome ceiling echoes may sometimes be obviated. The system is not a remedy for excessive reverberation; on the contrary, the increased loudness adds to the confusion. The system may be a valuable corrective when steps have been taken to reduce reverberation by introducing absorbent material—a procedure which of itself unfortunately decreases the volume of sound. It has, of course, to be recognised that in some cases the rendition of an amplifier and loud-speaker may not be wholly acceptable to a cultivated ear. The amplification should not be excessive or unnatural effects will result, nor should the different loud-speakers be widely separated or effects of repetition akin to echo will be produced. In Great Britain the system has so far been installed notably in large cathedrals, *e.g.* Liverpool Cathedral, Westminster Abbey, and Bath Abbey. An alternative method of amplification is employed in the House of Lords, where certain seats are equipped with ear phones, for the purpose of affording assistance to individual auditors who suffer from deafness.

ABSORPTION COEFFICIENTS.

We see that for a room to attain its optimum reverberant condition, it is necessary to arrange that the various exposed surfaces shall possess in the aggregate the requisite absorbing power. We thus require to know the absorption coefficient or the absorbing power of unit area of each material present.

Various methods have been employed for measuring this coefficient of absorption for building

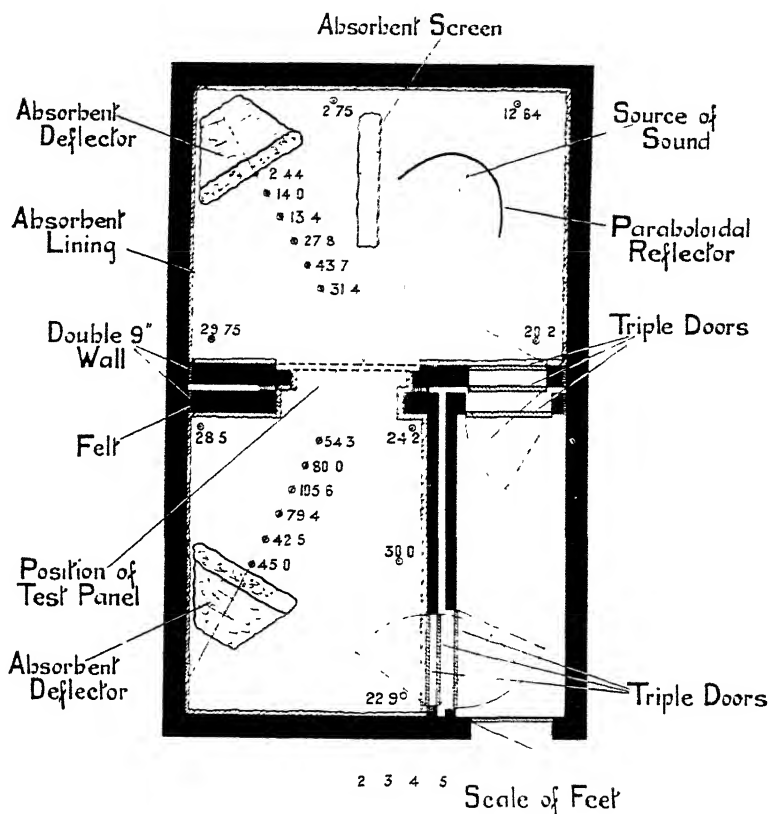


FIG. 2.—Sound-proof rooms at the National Physical Laboratory, Teddington, for measurement of transmission and reflection coefficients.

and other materials. One method is to measure the change in the reverberation period in a calibrated test chamber when a known and suitably large area of the material is introduced under proper conditions. In a second method, a beam of sound is directed towards a test specimen mounted as a panel in an aperture in a sound-proof wall, and the proportions of the incident sound which are reflected or transmitted are measured. Fig. 2 illustrates the use of this method by Dr. Davis and Mr. Littler at the National Physical Laboratory. In the case of small samples, another method is available for measuring the reflecting power. This is based upon measurements of the ratio of the intensities at the nodes and antinodes of the stationary waves in a tube, one end of which is closed by the test material.

Figures for the absorption coefficients of a number of materials have been determined by

Sabine and others. Per square foot, they range from 1.0 for an open window, 0.5 for hair-felt one inch thick, to about 0.01 for plaster or glass. Each isolated member of an audience is equivalent in absorbing power to about $4\frac{1}{2}$ square feet of open window. In the majority of cases the audience constitutes the most absorbent feature in a hall, so that the reverberation period is markedly responsive to the size of the audience.

SOUND-PROOFING.

The question of sound-proofing is often of great practical importance. As regards the transmission of air-borne sounds, they are best arrested by having the walls sufficiently massive and rigid.

In the case of structure-borne sounds, it is necessary for effective insulation to interrupt the continuity of the structure. For example, a sound-proof room may well be constructed like an inner box which is floated on insulators on the structural floor, and everywhere insulated from the structural walls and ceiling.

To conclude what is only a partial survey of the subject, it is evident that neglect of the established principles may lead to defective acoustic conditions which may prove to be incurable after a building is erected. Preventive treatment is preferable to curative, and architects should be prepared to allow acoustic requirements some share in influencing their designs.

Lister and Physiology.¹

By Sir C. S. SHERRINGTON, O.M., G.B.E., F.R.S.

IT is indeed fitting that we should recall on this commemorative occasion the contributions made by Lister to physiology. His very earliest scientific papers were all physiological. He may be said to have entered by way of physiology his surgical researches which were to achieve so much. His first paper was entitled "The Contractile Tissue of the Iris." It was work done by the microscope, which he used for the study of function rather than of form alone. It appeared in 1853, in the first number of the first volume of the now well-known *Quarterly Journal of Microscopical Science*. Lister was then twenty-five years of age. That the microscope should be his instrument for his maiden voyage of discovery was but natural in the son of his father, Joseph Jackson Lister, that remarkable man, who leaving school early for the business he conducted so successfully, yet found time to cultivate optics to such purpose as to devise and give to the world the achromatic microscope. Lister's earliest paper, this on the iris, supplied the first full and correct description of the radiating muscle dilating the pupil of the eye. It thus made a lasting mark upon its subject.

Lister's second paper, of a few months later, dealt likewise with involuntary muscle; this time in the skin, where had been recently discovered the arrector muscles of the hairs; a discovery which Lister confirmed and in several respects extended.

We may be struck by the remoteness of these Lister's first themes both from surgery and indeed from actual practice—they are frankly academic. I think we have to picture him a young man to whom the thing that really mattered was to engage at once upon research, caring less what in particular the research might be; a young man so ardently curious about Nature, especially animate Nature, that he turned enthusiastically to the problem that came first to hand. These papers in the simplicity of their text seem to reflect the Quaker upbringing of Lister's home. There is already that sobriety of expression which, character-

istic of Lister all his life, made yet the more impressive his own self-restrained statements of his great results later on. No man in his career had more excuse for, more justification for, hyperbole of phrase than had Lister, and no man ever indulged in hyperbole less than did he. It is therefore of significance when the young author allows himself an expansive adjective, as when he writes "the grand discovery of plain muscle-cells," "the beautiful muscle of the iris." We feel these expressions to be, from him, not mere phrases. An abiding interest of these youthful papers is their revelation of attributes in Lister's, so to say, original nature. Any reader of them must be struck by his power of penetrative and faithful observation, his patient enthusiasm, a restless testing of authority by observed fact, and an unhesitating self-submission to wherever the truth might lead.

His third paper, still physiological and on the same theme, smooth muscle, followed some four years later. The cellular nature of that tissue had been denied; Lister returned to its further proof. He furnished it overwhelmingly. Forty years afterwards the then foremost authority on this tissue wrote of this paper of Lister's as being still not only abreast but in several respects ahead of other subsequent papers on its subject.

This work proved, however, to be Lister's farewell contribution to that particular theme. To him by then much had happened and was happening to compel his main interest elsewhere. His scientific enthusiasm had indeed definitely orientated itself towards a chosen quest in the great field of the unknown. His spirit of inquiry had found a direction of overpowering interest to it. In his own words, written to his father, he had fallen in love with surgery; and with that widely detailed and highly technical art and calling prospectively spread before him, the genius within him impelled him to study not so much this or that particular skill or difficulty, but the fundamental and all-pervading process of inflammation itself as being for him the one prime and central problem for investigation.

¹ Discourse delivered in the Robert Barnes Hall of the Royal Society of Medicine on April 6.

Thenceforward Lister's physiological researches were merely side offshoots from that pathological study engaging his main thought; thus his paper on the nervous control of arteries, distinguishing between the immediately local and the more distant effects of a stimulus, and especially of an irritant stimulus upon the blood-vessels. The local effect, he concluded, was independent of the nervous system, but with a surrounding zone of effect mediated by nerve, a finding closely suggestive of present-day views. Another paper was that on the pigment cells of the frog's skin, the cells on which the animal's well-known colour changes depend. Lister concluded the shift of pigment to be an active shift of the pigment grains within the cells themselves, and the way in which he consolidated and marshalled his evidence for that proof is a striking example of his thoroughness as an investigator. There is little doubt that from detailed study of these pigment cells Lister gained much of that vivid and intimate conception of cell-life struggling against irritant agents which informed and directed his surgical strategy afterwards.

Another of his physiological investigations concerned the inhibitory nature of certain visceral nerves. He wrote: "I have been led to make an experimental inquiry into this so-called inhibitory agency because it appears to me to have an intimate bearing upon the question how inflammation is developed through the medium of the nervous system at a distance from an irritated part." His main conclusion was that inhibition resulted from more energetic action of those same nerves which, when working mildly, are excitatory. Then, and still more closely related to his pathological inquiries, followed two papers on clotting of blood, confirmatory, as he himself remarks, of his conclusions arrived at about inflammation.

These papers and the year 1862 conclude practically the tale of Lister's researches devoted directly to physiology. Perhaps their main interest now is their revelation of their author in his earlier research career. Conspicuous in them is capacity for noting detail and the rarer power of sifting out from it the broader meanings. Another of their qualities is the conscientious pains to observe for himself phenomena which many would be content to take on trust from the excellent descriptions already given by others. Lister as an observer was satisfied by nothing less than seeing for himself, and his eye never staled. There was also genius. What but genius could have whispered to him to make a frontal attack upon what then seemed the inevitable and universal process of suppurative inflammation itself. Surely in his choice of that problem there was genius, the humility of genius to set itself to begin at the very beginning, the daring of genius, to set itself to rebuild from the foundation. A further quality is the scientific courage which knows no fear except to lose the truth. Moreover, even at this stage, though he might appear engaged on diverse problems, he was in fact centred upon one, of which

from his point of view the several were but several aspects.

Thus from these early papers we see that in reality, almost from the outset of his career, he had not only found but had also flung himself upon what was to be his life-work and his life's problem—a problem we may imperfectly subsume under the one broad term 'inflammation.' That was the study which he was to follow to a practical solution so magnificently, and in so doing display what these earlier papers had less opportunity for showing, the splendid power of establishing and systematically pursuing to its consequences a great generalisation. Hence from these earlier researches we can see spring that triumphant career of experimentation and observation, in the laboratory and the ward, which, with a really surprising speed of mastery, winged surgery for that which she is to-day, a far-flighted angel of healing the civilised world over.

These papers, valuable though they are, whose features we have been examining, do not exhaust—far from it—the gift made by Lister to physiology. In addition to and beyond them he enriched it with the contribution of enhanced means towards its own most cherished aims. He put into the hands of physiology for all time a superlative refinement of its method and made possible observations otherwise impossible. Sir Berkeley Moynihan has recently eloquently insisted on the importance of surgery as a means to discovery. In physiology, how could Pavloff have achieved his epoch-opening study of the digestive processes except by leaning upon Lister's surgical principles? Was it not by means of Lister's surgical principles that Ferrier initiated his study of localisation of cerebral function? How could the physiologists of Toronto less than four years ago have bestowed upon diabetic sufferers that merciful remedy insulin, had it not been for the legacy of operative principle and science bequeathed to them and to the whole world by Lister?

Lister's own words leave us in no doubt as to the source of rejoicing it was to him that among benefits accruing from his work was this of an enlarged scope and power for physiology and experimental medicine. He dwelt, both in public and in private, upon the need and importance of such experimentation for the progress of knowledge necessary to civilisation. He rejoiced that he had contributed to man's power in that way. Indeed, the experimentalist owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to.

Of the gifts from Lister to humanity, one which the experimentalist is ever mindful of with especial gratitude is that, while helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Man, sacrificing animal life as he does to satisfy the material needs of human kind, has the right to regard the intellectual and moral impulse driving him to mitigate and dominate disease, as justified in its resort to animal experimentation. He feels the more fully justified in doing so, and takes that step

with a clear conscience, because largely owing to Lister it can be taken without inflicting pain or suppuration.

Thus it is that through years to come, after, indeed, it may be the actual papers contributed to physiology by him have become matter chiefly for the historian and the antiquarian, Lister will still receive unfailingly his meed of commemoration from the physiologist and experimentalist, and in a manner which to himself would of all ritual and

offering have been the most congenial—namely, in their daily observance and trust of methods which he discovered and inculcated, and in the practice of them for the alleviation and prevention of disease. It is therefore with peculiar gratitude that physiology brings its tribute of admiration and veneration to the memory of one great in character as in achievement, and great even among the greatest of the benefactors of mankind, Joseph Lister.

Obituary.

PROF. IRA REMSEN.

SOON, few chemists will be left who have passed the age limit. Already, during this year, three of my oldest friends, all distinguished chemists, have ceased to be. Hermann Wickelhaus, who was my fellow-student at the Royal College of Chemistry, Oxford Street, under Frankland in 1866; Carl Graebe, who was *privat docent* and worked at a bench close to mine in the old laboratory in Leipzig in 1868; Ira Remsen, the American, who went to Germany when I did, whom I did not meet, however, until after the Johns Hopkins University was established. The first was concerned with Darmstaedter, in 1869, in introducing the soda-melt into the naphthol industry; the second stands for quinone and artificial alizarin; the third for saccharin: all very notable connexions.

The story of Ira Remsen's career has been well told by Dr. B. Harrow in "Eminent Chemists of our Time" (T. Fisher Unwin, 1921). He was of Dutch parentage. The elegance of his name was matched by the elegance of his person: he was always a man of gracious presence and owed much of his success and influence to his attractive personality. Five years' serious study in Germany made him both a real chemist and a modest man—with a sense of proportion not always to be found to-day in the chemist, particularly in his own country. His career before going abroad is of interest, as showing how miserable were the opportunities of students in his youth. His father made him take up medicine and apprenticed him to a medical man, who was teacher of chemistry in the Homeopathic Medical College, New York, whose teaching consisted in giving him a book and telling him to read. A casual experiment which he made (with generally destructive results) to ascertain what was meant by "Nitric Acid acts on Copper" seems to have infused him at this time with a special interest in chemistry.

However, Remsen graduated in 1867, at twenty-one, as doctor of medicine, submitting a thesis on the fatty degeneration of the liver—of which he was profoundly ignorant. He then insisted on going abroad to study the subject for which he had a liking. He first worked, during a year, in Munich with Volhard, then two years in Göttingen with Fittig, taking his Ph.D. in 1870. He spent the next two years at Tübingen as assistant to Fittig. He was, therefore, under the best of influences in Germany.

Remsen found no immediate opening on his return but eventually became professor of physics and chemistry at Williams College—without a laboratory. We are told, that when he preferred a mild request for one, the president's answer was: "You will please keep in mind that this is a college and not a technical school. The students who come here are not to be trained as chemists or geologists or physicists. They are to be taught the great fundamental truths of all sciences. The object aimed at is culture, not practical knowledge." With which immortal discourse the great man dismissed the subject, says Remsen's biographer, as though the view expressed were a mistaken one. I am inclined to think that Remsen, to-day, would perhaps be inclined himself to give a similar answer, though without advocating 'no laboratory.' An I be not mistaken, the advice thus given by the president of Williams fifty years ago is much needed throughout the university world to-day, especially in the U.S.A. culture—knowledge of the great fundamental truths—is what is now most wanted among us: students get it nowhere.

At thirty, Remsen became professor of chemistry at the Johns Hopkins post-graduate university established, in Baltimore, in 1876. Ultimately, he was president of the University. He is to be credited with two great achievements: in 1879, together with Fahlberg, he discovered saccharin; he also started the *American Chemical Journal*, which he carried on until 1914, when it was merged in the *Journal of the American Chemical Society*. Saccharin is now an excisable article in our free-trade country. There are three factories making it. For the year ending Mar. 31, 1926, the total duty collected was £83,118, of which the Customs duty on imported saccharin amounted only to £567. The rates of duty for sugar and saccharin respectively are 11s. 8d. per cwt. and 3s. 9d. per ounce. This is approximately as 1:550, the ratio of the assumed sweetening powers of sugar and saccharin.

The retention of benzoic acid as a permitted preservative in food is due to a Board appointed by President Roosevelt, in 1909, of which Remsen was chairman. He and other members tested its action upon themselves—and lived through the trials. The public generally here has lived through trials upon itself with far larger amounts of boric acid, which is disallowed—although no *scientific* proof of its harmfulness has yet been given. Maybe, the presence of preservatives in food is entirely

undesirable. It should, however, be understood that they have been rejected on grounds other than scientific.

It is to be hoped that a carefully studied life of Remsen may be written, to display to his countrymen the many important lessons which are to be derived from the career of a man possessed by an abundant clarity of spirit, sure in his judgment and rare in his courtesy, gifted with breadth of outlook and sense of proportion and of wide experience. Without being a genius, he was deeply devoted to his subject and well versed in its mysteries. We have yet to learn whether the establishment of the Johns Hopkins University, a unique institution, with which he was so intimately connected, has been justified by results. We may suspect that, as in all other institutions, success in so far as it has been attained, has been the product of leadership. In modern times, killing the slain with the aid of the beginner has been developed to the finest of arts, under the guise of research. We need to take stock and consider, if considered study of what is known be not the better preparation even for the future inquirer and whether the assembly of original workers *en masse* be indeed desirable.

HENRY E. ARMSTRONG.

MR. A. B. DEACON.

THE science of anthropology has suffered a grievous loss by the death of Arthur Bernard Deacon in Malekula, New Hebrides, of heart-failure following black-water fever, on Mar. 12. Mr. Deacon was born of British parents at Nicolaiev, South Russia, on Jan. 21, 1903, and came to England in 1916. He attended the Nottingham High School, where he did remarkably well. He obtained a State Scholarship, an Old Boys' Exhibition, and an Open Scholarship at Trinity College, Cambridge, and obtained firsts in the Natural Science Tripos, Part I, in 1923, the Mediæval and Modern Languages Tripos (Literature and History), with distinction in Russian, in 1924, and the Anthropological Tripos in 1925, and was appointed to the Anthony Wilkin Studentship.

While still a student, Deacon wrote a suggestive paper, "The Kakihan Society of Ceram and New Guinea Initiation Cults" (*Folk-lore*, 36, 1925, p. 332), in which he correlated the ghost-societies of Melanesia with the initiation cults of the Melanesian-speaking peoples in the Mandated Territory of New Guinea on one hand and with the Kakihan of Ceram on the other; the latter is essentially a 'ghost-society' and most completely represents the original cult.

Later in 1925, Deacon went to the New Hebrides. While waiting at Espiritu Santo for a boat to Malekula, he did some useful preliminary work and got into touch with natives from other islands; the following year he did excellent work in Ambrym. In 1926 he landed at South-West Bay, Malekula, on his birthday, and at once got to work, but he found a "general chaos of native life" and an "utterly appalling depopulation." In dispiriting circumstances he gathered all that he could in this

district, and later spent three months in north-central Malekula, where he obtained good results, though even there the "death-rate has been ghastly." He gathered a good deal of detailed information about social regulations, relationships, etc., cannibalism, chieftainship, polygyny, songs, games, and also made the surprising discovery of remarkable geometrical designs, of which he collected some sixty examples. These and his other investigations will be published in due course.

The results obtained by Deacon far exceed what might be expected from a first attempt in field-work, and they prove that he had an exceptional aptitude for anthropological investigations. Those of his notes which have reached me show that he was fully alive to the problems concerned, and that, though interested in details, he was continually alert to the conclusions to which they pointed. His death is an irreparable loss not only to science but also to all who came into contact with him. He was a cultured, talented man with a charming modesty and with a sure promise of a brilliant future.

A. C. HADDON.

AN account of the life and work of Dr. Luigi Casale, written by Dr. J. F. Crowley, who has been closely associated with the Italian chemist, appears in the issue of *Chemistry and Industry* for Mar. 11. Casale was born in 1882 at Langosco and was educated at Turin. He became head of the organic chemistry laboratory in the institute of general chemistry in the University of Turin in 1913. In 1915 he became head of the pharmaceutical chemistry laboratory of the University of Naples, where he carried out important investigations for the Italian War Office. Dr. Casale became interested in nitrogen fixation in 1917, and shortly after 1920 commercial plants for the production of synthetic ammonia by his process were in operation. The Casale process has been adopted in many parts of the world: the total capacity of the plants completed or in course of construction using this process amounts to 250,000 tons of ammonia per annum. The total world output of synthetic ammonia in 1925 was 350,000 tons. Dr. Crowley refers to the great personal charm of Dr. Casale, his high qualities as an investigator, and the loss which applied science has sustained by his early death.

WE regret to announce the following deaths:

Mr. G. L. Cathcart, senior fellow of Trinity College, Dublin, who for many years edited Salmon's mathematical works, on Mar. 26.

Prof. D. A. Gilchrist, who recently retired from the chair of agriculture at Armstrong College, Newcastle-on-Tyne, on April 4, aged sixty-seven years.

Prof. C. S. Sargent, of the Arnold Arboretum, near Boston, foreign member of the Linnean Society of London, aged eighty-five years.

Prof. O. Sars, formerly Director of Fisheries Research in Norway, foreign member of the Linnean Society of London, and author of a monograph on the Crustacea of Norway, on April 9, aged eighty-nine years.

News and Views.

THE appointment of Mr. H. T. Tizard as successor to Sir Frank Heath as Secretary of the Committee of the Privy Council for Scientific and Industrial Research, which has recently been announced, will be welcomed by many. He is a scientific worker whose work on internal combustion engines has brought him well-earned distinction; he has had considerable experience as an aviator, having been for a long time in command of the test squadron at Martlesham Heath; and it is obvious that he has proved his capacity as an administrator during the years he has been on the headquarters staff of the Department of which he is now to become the administrative head. His appointment is a further challenge to the belief cherished in certain circles that a man who has achieved distinction in a specialised field in science must necessarily become narrow in outlook and less fitted to undertake the duties and responsibilities of administering a department of State than one who has achieved distinction in classical, historical, or literary studies. Those scientific workers who believe that a scientific training and outlook are indispensable qualifications for the task of administration in the modern State will find Mr. Tizard's appointment peculiarly gratifying.

THE British patent system has undergone no fundamental change since the introduction, by the Patents Act of 1902, of a tentative step from the French towards the German or American plan, and the present rather illogical compromise has found practically no imitators amongst the industrial countries of the world. The system has now been on its trial for a quarter of a century, and it should be possible to learn, from the experience gained during that period, what further changes would probably be beneficial in stimulating British industry. In these circumstances the British Science Guild has appointed a strong committee to explore the question of possible reform: the chairman is Prof. W. H. Eccles, and the members include, amongst others, Mr. James Whitehead and the Hon. H. Fletcher Moulton, of the Patent Bar; Messrs. H. A. Gill and Dunbar Kilburn, representing the patent agents; Messrs. William Martin and A. F. Ravenshear, both authors of well-known books on the patent system and formerly members of the examining staff of H.M. Patent Office; Sir Richard Gregory, Dr. A. Ree, and Messrs. S. G. Brown and C. C. Paterson. The only criticism suggested by a scrutiny of the list of members is that manufacturers and inventors themselves, particularly those who have succeeded in establishing new manufactures with scanty financial backing, might with advantage be somewhat more largely represented. Actual legislation can scarcely be expected without the inevitable preliminary of a Government committee, but invaluable pioneering work can be done by an expert if unofficial committee like that which has just been set up, and should the latter arrive at positive conclusions, Government action of some kind could scarcely be refused.

A SERIOUS drawback to the more general use of valve sets for receiving broadcasting is the necessity of having a high-tension dry battery, a low-voltage accumulator, and a medium-tension battery to give the grid a bias. For several years consumers have wondered why inventors have not designed apparatus which would give the required voltages from a public electric supply system. One of the difficulties which has to be overcome before this can be done is to eliminate the high-frequency ripple which is present in direct-current supply systems which use dynamos as generators. If we put a telephone in series with a megohm and connect the two in series across the supply mains, an almost intolerable scraping noise will be heard, due to the commutator segments of the generators moving past the brushes pressing on them. The first thing that has to be done, therefore, is to eliminate this ripple by means of a suitable electric filter. If the supply is alternating current, a rectifier to make the current pulsate always in one direction must be used in addition. The lighting supply also is at a high voltage, and to avoid fire risk the receiving set must be much better insulated than it is usually. The great boon, however, of being able to get rid of the trouble and expense of charging accumulators and maintaining them in good order would counter-balance the extra expense of having a standardised receiving set which could be operated from the lighting mains.

IN a paper read to the Institution of Electrical Engineers on April 6, P. R. Coursey and H. Andrewes discussed the apparatus required to operate radio-receiving sets from the electric-lighting mains. Appliances of this kind are generally referred to as 'battery eliminators,' but this name does not seem to be happily chosen. Simple filter circuits were described which effectively eliminate the hum caused in the telephones or loud speaker by the ripple in the supply. It is found in practice that with ordinary lighting pressures a ripple of amplitude equal to 0.2 of a volt is not an appreciable drawback. In one system the ordinary accumulators are used and are charged automatically from the supply mains at a low rate, whenever the radio set is not in use. The authors call this device a 'trickle charger.' The disadvantage of the method is that either the battery is overcharged under normal conditions, or else it may not last sufficiently long should it be required to be in operation for a longer period than usual. In another method, no accumulators are used, the cathodes in the valves being heated by means of an internal heating element which is operated directly from the lighting mains. It will be seen that the problem has been practically solved. What is now wanted is a standardised radio-receiving set actuated from the lighting mains, which can be bought at a reasonable price.

THE first national bird sanctuary to be created in Scotland is now in being, and a "Report of the

Committee appointed by Viscount Peel to consider the establishment of Bird Sanctuaries in the Royal Parks of Scotland" (H.M. Stationery Office, price 6d.) indicates the progress which has been made during the first year of the reservation of Duddingston Loch. An interesting appendix to the Report, on "Duddingston Loch and its Bird Life," summarises the three lines along which steps have been taken to increase the attractiveness of the area, which lies within the bounds of greater Edinburgh, for migrating and nesting birds: first, by preventing the actual depletion of the resident bird life which has until now taken place through the destruction of eggs and nests by trespassers; secondly, by adding new cover, which may afford nesting sites during spring and summer for more birds and greater variety of birds, especially of the smaller kinds; and thirdly, by providing shelter and a natural food supply during the autumn and winter, which may induce migrant birds to halt awhile on their southward journey. At the outset of its existence as a sanctuary, Duddingston Loch and its immediate surroundings possessed a bird population consisting of 17 resident and breeding species, 40 regular visitors, and 16 casual or occasional visitors. It is hoped that each of these classes may be added to as the plans of the Committee become effective.

MR. C. L. WOOLLEY's final report on the season's work at Ur, in the *Times* of April 12, chronicles the premature stoppage of excavation on Feb. 19 owing to lack of funds. This is tantalising, in that the expedition was then working on one of the most promising sites it has yet touched, and had unearthed a treasure which in the number and character of its relics is probably as rich as any that has yet been found in Mesopotamia, and may justly, as the director claims, be compared with that of the tomb of Tut-Ankh-Amen. From the chronological point of view in particular, its importance is marked. At the topmost level were graves dating to about 2600 B.C., as was shown by two seals of members of the household of the daughter of Sargon of Akkad; below were graves similar in character with basket-work coffins or simply a lining of matting, but of earlier date, as shown by the associated objects, and belonging to the period between 3200 and 3100 B.C.; and below these again were series of graves of which the earliest must go back to 3500 B.C. It is these last which have proved of such unexampled richness, the finds including decorated and engraved shell plaques, and a hoard consisting of quantities of copper implements and weapons. Scattered on the ground were a number of carnelian, lapis, and gold beads, the gold binding of a bow, an adze of solid gold, of which the handle was covered with gesso painted red and bound with gold, a silver baldric with a 'vanity case' of gold toilet implements attached, and a marvellous dagger with a hilt of lapis lazuli studded with gold, a blade of burnished gold, and a sheath of gold of which the front is covered with a design in filigree. This is one of the oldest known examples of the goldsmith's art. It seems scarcely credible that an expedition sent out by a national institution

which had obtained such important and remarkable archaeological and historical evidence as has been brought to light at Ur, should have to cease work through lack of funds just when so noteworthy a result had been achieved.

It is satisfactory to record that many of the finer stone implements recently sold with the Hewlett Collection will be kept together. We are informed by Mr. Alexander Keiller that about a half of the flints from the eastern counties, and by far the greater number of the picks and axes from the South Downs collected by Mr. S. G. Hewlett, have found a home in his Museum at 4 Charles Street, London, W.1. In Mr. Keiller's opinion, an explanation of the low prices which prehistoric implements fetch at public auctions, is that they are put up for sale in boxes of 30 or 40 together in a lot, and so dirty that only the most scrupulous examination before the sale, coupled with a vivid imagination, will enable the prospective buyer to discover the treasures. Consequently their true value is seldom appraised by more than one or two of those who afterwards bid for them. Mr. Keiller informs us that his collections include portions of the Hewlett, Knowles, Crawshay, Kendall, Wilks collections, while one section is confined solely to housing the finds of all descriptions—flint implements, pottery, bone, and so forth—from his and Mrs. Keiller's annual excavations of the neolithic site of Windmill Hill in Wiltshire, together with the surface finds of flint implements from that site and from others nearby. The collections are open to view to any one recommended by a recognised Society.

THE British Isles were magnetically surveyed by Rücker and Thorpe in 1884-1888, 205 stations being occupied; and again, in much greater detail (677 stations), in 1889-1892. Then a long interval followed before the next survey, of 183 stations, by G. W. Walker in 1914-1915. In future the Ordnance Survey will undertake magnetic surveys, and it has been decided that the first re-survey shall be made by five annual tours, re-occupying Walker's stations (with a few additions and omissions as may prove necessary), beginning in 1926. When this programme has been completed, the speed of subsequent revisions will be considered. H.M. Stationery Office has just issued "Results of the Magnetic Observations made by the Ordnance Survey in the Channel Islands in 1925 and in Southern England in 1926" (9d. net); it gives values of the three magnetic elements for 7 stations in the Channel Islands and 30 in Southern England. The data are corrected to the epoch 1925.5 or 1926.5, using Greenwich or Abinger as base station. The corresponding data from the last previous survey are given for comparison.

THE losses caused by mosaic diseases of cultivated plants have of recent years assumed alarming dimensions, and at the present time these virus pests are the most destructive pathogens of potato crops both in Great Britain and America. Every year brings records of some new victims of these diseases,

and serious mosaic attacks on the sugar-cane have just been reported from Cuba. The problem in this particular case is complicated by the fact that certain wild grasses are not only themselves susceptible to this form of mosaic disease, but also harbour the insects responsible for transmitting the infection. In the meantime the Smithsonian Institution and the Tropical Plant Research Foundation are co-operating in an attack on the problem, and Prof. Hitchcock is already busy collecting and identifying the grasses likely to be concerned in the propagation of the disease.

THE Minister of Public Instruction of the French Republic, having ratified the nomination made by the Council of the Faculty of Medicine of Strasbourg, Prof. George H. F. Nuttall, Quick professor of biology in the University of Cambridge, has been made professor, *honoris causa*, of the University of Strasbourg.

AT the meeting of the London Mathematical Society on Thursday, May 12, at 5 P.M., at the Royal Astronomical Society's Rooms, Burlington House, Prof. H. F. Baker, Lowndean professor of astronomy and geometry in the University of Cambridge, will deliver a lecture on "Geometry and Differential Geometry." Members of other scientific societies are invited to be present.

SIR JOHN RUSSELL, Director of the Rothamsted Experimental Station, Major Walter Elliot, Parliamentary Under-Secretary of State for Scotland and chairman of the Research Committee of the Empire Marketing Board, and Dr. J. B. Orr, Director of the Rowett Institute for Research in Animal Nutrition, Aberdeen, are on their way to Palestine to inquire into problems of animal husbandry and dry farming. The delegation will meet delegates from Cyprus, and probably also from Iraq.

A DANISH scientific expedition, under the leadership of Prof. C. Olufsen, and supported by the Carlsberg Fund, is now on its way to Senegal to explore the upper region of the valley of the River Niger, the Upper Volta, and the south part of the Sahara, especially Air (Asben or Agadiz). The expedition, the main purpose of which will be to collect objects of ethnological interest for the Danish Museums, is to return via Zinder and Kano, through Nigeria, to the Guinea Coast, and thence by sea to Dakar. Prof. Olufsen will be accompanied by two Danish scientific workers, Mr. Oluf Hagerup (botanist) and Mr. Harry Madsen (zoologist).

DR. F. L. PYMAN, professor of technological chemistry in the University and in the College of Technology, Manchester, has been appointed head of the research laboratories of Messrs. Boots Pure Drug Company, Ltd. The firm has decided to extend the scope of the research work carried out at Nottingham, and for this purpose new laboratories are being equipped, whilst the staff of research chemists is to be increased. A primary object of this new development is the prosecution of fundamental research in the domain of chemotherapy, and Prof. Pyman's high

qualifications and scientific record are a sufficient guarantee that a high standard will be maintained. His better-known investigations are concerned with the chemistry of the alkaloids and of synthetical compounds closely related to them; recently he has devoted much attention to the glyoxaline group and has effected a brilliant synthesis of one of the most important members of the series, namely, histidine, a structural unit of some protein molecules.

THE Council of the Illuminating Engineering Society has unanimously nominated Mr. D. R. Wilson as president for the coming session. Mr. Wilson has been associated with much valuable pioneering work on industrial lighting. The reports of the Chief Inspector of Factories for 1911 and 1912 contained special contributions by him dealing with problems in factory lighting, and in 1913 he took an active part in the formation of the Home Office Departmental Committee on Lighting in Factories and Workshops, of which he became secretary. He has since taken a leading part in bringing the benefits of good lighting before the various joint industrial councils, and he is a member of the Illumination Research Committee working under the Department of Scientific and Industrial Research. The impartial position of Mr. Wilson, as well as the services he has rendered to illuminating engineering, will no doubt ensure this nomination receiving the cordial support of members of the Illuminating Engineering Society.

APPLICATIONS for grants from the Dixon Fund for assisting scientific investigations must be made before May 15 to the Academic Registrar, University of London, South Kensington, S.W.7. They should be accompanied by the names and addresses of two references.

THE tenth Italian Geographical Congress will be held at Milan on Sept. 6-15 this year under the patronage of the King of Italy and the honorary presidency of the Prime Minister. It is being organised by the Italian Touring Club. There will be five sections: (1) Physical and cartographical; (2) historical; (3) political and economic; (4) explanation; (5) education. At the conclusion of the meetings there will be a number of excursions, by rail or road, to various parts of Italy. During the Congress there will be an exhibition of recent Italian maps and photographs.

THE Russian Academy of Sciences has started publishing a special series of "Contributions on the Resources of the Yakutsk Republic," embodying the results of various expeditions carried out during recent years. The first volume contains an exhaustive memoir of V. L. Komarov on the flora of Yakutia, including the history of botanical exploration, a complete list of plants, exhaustive bibliography, and several useful maps. The second volume, by E. Stelling, D. A. Smirnov, and N. V. Rose, deals with observations on terrestrial magnetism in Yakutia, where is located the largest known area of anomalous magnetic phenomena; the work includes complete records of numerous magnetic observations in the

country since 1893. Other parts already published are on fishes of the Khatanga basin, by L. S. Berg; on the Coccinellid beetles of Yakutia, by F. G. Dobrzhansky; on the hydrology of the eastern Siberian Polar Sea, and so on.

A RECENT issue of the *Bulletin of the American Mathematical Society* gives interesting historical particulars of the Society's development. Founded in 1888 as the New York Mathematical Society, its activities soon assumed a national character, the title 'American' dating from 1894 and the *Transactions* from 1900. The Society's meetings are held at various centres in the country from time to time, a practice that could well be adopted by some of the English learned societies which meet only in London. Ten colloquia connected with the summer meetings of the Society have been held, the lectures given at the more recent ones being available in book form. In 1914 the membership had reached 700 and the Society was recognised as one of the world's great scientific societies. At the end of the difficult War period, the Society, like most similar bodies, was faced with a serious financial crisis due to the great increase in the cost of printing its *Transactions*. The membership has now increased to 1700, and more than thirty sustaining members, comprising some of the great engineering firms and insurance companies of the country, as well as several universities, contribute annually to the support of its activities. In the last direction also there is scope for similar development in Great Britain.

ON several previous occasions we have directed attention to the sets of coloured post-cards issued by the British Museum (Natural History), South Kensington, London, S.W.7, and illustrating British or exotic insects contained in the collections. Four new series illustrating exotic moths (sets E45 to E48) have recently appeared. The 47 examples depicted on the fifteen cards in sets E45, 46, and 48, are selected on account of their rarity, while set E47 illustrates the occurrence of eye-spots in various families of moths.

In all cases direct colour photography has been used of actual specimens, and the reproductions portray their coloration and form with remarkable fidelity. Each set consists of five cards, and is obtainable at the Museum, price 1s. per set.

WE have received a copy of the Catalogue of the Collections in the Science Museum, South Kensington, Chemistry Section, published for the Board of Education (London: H.M. Stationery Office, 1927). The catalogue, which is illustrated by plates and contains interesting descriptive notes of the exhibits, forms a useful guide to the collection in the Museum. Among the exhibits are a replica of Black's balance, some of the original apparatus used by Graham in experiments on colloids and on gaseous transpiration, Hartley's quartz spectrograph, specimens of synthetic rubber prepared by Sir William Tilden in 1892, several specimens which belonged to Faraday, and reproductions of other notable apparatus. There are also collections of specimens intended to illustrate important branches of chemistry, such as synthetic and natural dyes, alkaloids, vitamins, and laboratory apparatus.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A resident tutor in economics in the University of Bristol—The Registrar (April 30). Part-time gas examiners under the London County Council—The Clerk of the London County Council, The County Hall, Westminster Bridge, S.E.1 (May 9). A qualified dentist and a woman assistant under the Medical Research Council for work in connexion with a special investigation into the causes, progress, and prevention of dental caries in children—The Secretary, Medical Research Council, 15 York Buildings, Adelphi, W.C.2 (May 11). A pathologist and bacteriologist at the Hospital for the Insane, Claremont, Western Australia—The Agent General for Western Australia, Savoy House, 115 Strand, W.C.2 (May 16). A lecturer in physics in the Queen's University of Belfast—The Secretary (May 28).

Our Astronomical Column.

KORDYLEWSKI'S VARIABLE STAR.—This very remarkable variable, the position of which for 1927.0 is R.A. 12^h 33^m 16^s.6, S. Decl. 17° 7' 3", is in the same field as S Corvi, and was first seen by the discoverer, at Cracow Observatory, on Dec. 14, 1925. He was familiar with the field, as he was in the habit of observing S Corvi and noticed the presence of a strange star, the magnitude of which on the B.D. Scale was 9.5 or brighter. There were then two months of cloudy weather, after which he failed to find the stranger. Search on the Harvard plates was at first abortive, but a recent Harvard post-card circular announces that images have been found on seven plates taken between 1895 and 1908. They suggest a period of about 400 days, which is confirmed by the star's recent reappearance. The range of photographic magnitude is from 11.5 to less than 17, and therefore about the same as that of Mira Ceti.

Recent photographs by Herr Pavel at Babelsberg on plates of different types show that its colour index is greater than 1.5^m, which would explain its visual brightness at the time when Kordylewski discovered it. The star was in opposition to the sun at the

beginning of April, and is therefore well placed for observation during the next two months. Observations are very desirable in order to determine the character of the light curve. Owing to the large colour-index, the type of plate used should be noted in photographic observations.

CALENDAR REFORM.—Mr. M. B. Cotsworth, known to most computers by his useful calculating tables, is an enthusiast for calendar reform, and has published a pamphlet on the subject under the auspices of the Pan-American Union. He traces the history of the calendar from early times, noting the great advantage that the use of a solar year gave to all nations to whom agricultural operations were important. He seems to be in error in stating that a 'leap-year' was used in ancient Egypt. His suggestions for reform of the calendar are now familiar, namely, 13 months of 4 weeks each, and one day each year (two in leap-year) that stand outside the weekly reckoning. Both suggestions excite considerable opposition, and there appears to be little prospect of general agreement upon them.

Research Items.

HUMAN SKULL FROM KENT'S CAVERN, TORQUAY.—A skull found last year by the owner of Kent's Cavern is described by Sir Arthur Keith in vol. 4, Pt. 4, of the *Transactions of the Torquay Natural History Society*. The skull had evidently been deposited in a fissure in the rock, and although nothing was discovered which would assist in determining its age, two shells found at the same level near by have been identified as Pleistocene, while the condition of the skull fragments is such as is usually found in bones discovered in or under the stalagmite floors of limestone caves in England. The skull on reconstruction by Sir Arthur Keith is clearly that of a female, short and relatively broad, length 175 mm. (estimated), breadth 143 mm., cephalic index 81.7. It is high, the highest point of the vault being 120 mm. above the upper margin of the ear. The upper part of the forehead is prominent, projecting in front of the glabella. The face is remarkably short and narrow, the nose short, flat, and snub. All the teeth were healthy and present at the time of death, which took place about the age of twenty-five years. The palate is virtually identical with the half a human palate found embedded in stalagmite at a depth of 20 inches by Mr. Pengelly in 1867. The skull in form is identical with the remarkable rounded high-vaulted skulls of late palæolithic date found at Aveline's Hole, and comparable to the skulls of very similar form found at Solutré in France, which thus suggest a possible place of origin for these palæolithic brachycephals of late palæolithic age in Britain.

AMERICAN-INDIAN MUSIC AND MUSICAL INSTRUMENTS.—In *La Nature* for Mar. 15, Dr. Paul Rivet discusses the music and musical instruments of America, especially of Central and South America. He notes that while collections have been made in the northern half of the continent, little has been done for the rest of America, this being all the more surprising because of the marked effect which, it has been stated, such music has on the Spanish American. The lack of recorded material has been remedied in some degree by the publication in 1925 of a careful study of Peruvian Music by M. and Mme. D'Harcourt (Paris, 1925) which deals with the music of the Incas and its survivals, and comparatively with the indigenous music of other parts of America. Before the conquest, the Indians used wind and percussion instruments only. The different types of each present some peculiarities of distribution not easy to explain. The wooden drum, the *teponastli* of the Mexicans, for example, is found only in the Antilles basin and the north of South America; the pipe, which is spread over the whole of the north of South America, does not cross the Panama isthmus; while the ocarina occurs only in central and north-west South America. The vertical flute or whistle, or its near relative the flageolet, is found all over America except in the extreme north and south. The Peruvians used only the straight whistle form and not the flageolet, but extended it to eight notes as against the five of the Mexican flageolet. It attained its most highly developed form in the pottery panpipes of Nasca, which were sometimes strikingly ornamented with decorative motifs. Among the instruments of America it is possible to determine foreign origin and the provenance of a number, but others present greater difficulty, such as, for example, the musical bow. Such cases may lend support to the theory of an Oceanian origin in part of the American people which M. Rivet has already supported on other grounds.

GLASS FRAGMENTS IN PRESERVED FOODS.—From the fragile nature and extended use of glass containers for foods and beverages, it might be expected that glass fragments will from time to time occur in the material and cause injury to the consumer, and the Ministry of Health therefore instituted an investigation on the subject (Ministry of Health. Reports on Public Health and Medical Subjects, No. 37: A Report on the Occurrence of Glass Fragments in Foods packed in Glass Containers. By George C. Hancock. London: H.M.S.O. 1s. net). The records for the past five years of four of the largest London hospitals have been searched, but no cases of injury by glass fragments have been met with. A large number of samples has been examined for the presence of glass. In one series of 156 samples, glass fragments were present in 113 (= 72.4 per cent.); but with few exceptions, the glass is present in finely powdered form ($\frac{1}{16}$ in., $\frac{1}{32}$ in. or $\frac{1}{64}$ in. in size) and as such appears to be quite harmless. The largest fragment found was a splinter measuring $\frac{3}{8}$ in. \times $\frac{1}{16}$ in. in pickles. Details are given of the method of examination and identification. The residue, after destruction of the organic matter, is collected and examined microscopically. Glass splinters are transparent and usually present characteristic sharp edges. Under the polarising microscope with crossed nicols, glass fragments are invisible and the field dark, but crystals and siliceous fragments appear bright on the dark background.

NEW OR RARE FISHES.—In *Proc. Acad. Nat. Sci. Philadelphia*, vol. 78, 1926, Messrs. C. F. Silvester and H. W. Fowler describe and figure a single individual belonging to the rare and remarkable family of fishes, the Anomalopidae, which was found floating on the surface of the sea off the coast of Jamaica in July 1908. The discovery is one of unusual interest, connecting as it does West Indian waters with a small restricted family of fishes thought to be confined to the Indo-Moluccan archipelago and the South Pacific. The specimen is placed as the type species of a new genus, with the name of *Kryptophanaron alfredi*. It possesses the peculiar phosphorescent organs characteristic of the family, and, at will, is able to turn on or off the stream of light. Full generic and specific descriptions are given, as well as a revised synopsis of the genera belonging to the family. In the same volume Henry W. Fowler gives detailed descriptions of fishes from several small collections recently received at the academy from Florida, Brazil, Bolivia, Argentina, and Chile. Though few of the species are new, a number are rare or unusual in collections. This paper is of a technical nature, giving the full morphological details upon which identification is based.

EUPHAUSIACEA AND MYSIDACEA FROM THE WESTERN ATLANTIC.—Prof. W. M. Tattersall has found much interesting material in the collections made by the United States Coast Survey steamer *Bache* in the Western Atlantic from January to March 1914. ("Crustaceans of the Orders Euphausiacea and Mysidacea from the Western Atlantic," No. 2634, *Proc. U.S. Nat. Mus.* vol. 69, art. 8, 1926). This area has hitherto been little explored for these groups, but only one new species was found, *Mysidopsis bigelowi*. Perhaps the most important find is the mysid, *Paralophogaster glaber* Hansen, only known up to this time from the Pacific Ocean near the Dutch East Indies and in the waters off New Zealand. The occurrence of the larvae of *Thysanopoda* (?) *cornuta* Illig from very deep water, 1100 m.-1800 m., is of

special interest. From the stations off Chesapeake Bay, where coastal and oceanic waters mix, three northern or boreal euphausians were obtained, including *Meganyctiphanes norvegica*, but all the other material consists of tropical oceanic species in great abundance. The author divides these oceanic species into three groups which characterise the upper (100 m.), middle (100 m.-200 m.), and deep water regions (below 200 m.) respectively, but as he himself says, he has not taken into account the possible diurnal movement of the species which certainly takes place, at any rate in some of the more neritic forms. There is also another fact which might be considered, and that is the tendency which is apparent in many species to approach the coast when breeding and the consequent presence of larval and immature forms in much shallower water. This might possibly account for the numbers of *Euphausia Krohnii* and *Nematoscelis megalops* near Chesapeake Bay. It is not stated whether they were adult or immature. The large numbers of truly oceanic euphausians is well shown in these records, in which much that is new is brought out as regards the distribution of both common and rare species.

UPPER CRETACEOUS FOSSILS OF TENNESSEE.—A series of unusually well-preserved fossils from the Ripley formation (Upper Cretaceous) has recently been discovered at Coon Creek, a few miles to the north-west of Savannah on the Tennessee River, State of Tennessee. This fauna, mainly molluscan, but including examples of other invertebrates and bones of a mosasaurid, has been subjected to systematic study by Mr. Bruce Wade (U.S. Geol. Survey, Professional Paper 137). The geological relations, with a map, and the biological relations of the fauna, with a table of the distribution and range of the constituent species, are set forth in a clear and succinct introduction. The systematic descriptions follow and treat of 224 genera and 345 species, of which a large proportion are set down as new. There is also a good index. The 72 plates from retouched photographs are of the highest quality and a delight to look at. The artists responsible for them, Mr. W. O. Hazard and Miss F. Wieser, are to be congratulated on their excellent work, which contributes in no small degree to the value of this important monograph.

PALEONTOLOGICAL RESEARCH IN CRIMEA.—Since 1923 the Russian Academy of Sciences has been conducting excavations in the caves of the Crimea, and already very valuable data have been collected, enabling one to form some conclusions with regard to changes of climate and fauna of the Crimea since the middle palæolithic age. The deepest deposits contain many remains of mammals wholly, or nearly, extinct, such as mammoth, hairy rhinoceros, gigantic elk, cave hyena, urox, wild horses, Saiga antelope, and so on. It is particularly interesting that the last-named animal, which appeared in western Europe only for a relatively short period, was living in the Crimea until the beginning of the last century. The excavations supply also very important evidence as to which of the wild mammals are autochthonous in the Crimea, as, for example, the deer, and which are introduced by man. The investigations will be continued during the next season.

RAINFALL IN AUSTRALIA.—The Bureau of Meteorology of the Commonwealth has published an average annual rainfall map of Australia revised to 1924. Only stations with records covering not less than fifteen years have been used in the compilation, and

it has been found practicable to draw isohyets for all the continent except the central and western interior. The map does not materially differ from the rainfall maps of Australia already available, but shows a great deal more detail. Isohyets are drawn for every five inches and the colour tint is changed every ten inches, while the scale of the map is two hundred miles to one and a half inches. Thus allows the rainfall in the important areas of settlement in temperate Australia to be shown with considerable accuracy.

THE DISTRIBUTION OF ARCTIC ICE.—The Danish Meteorological Office has published its report on "The State of the Ice in the Arctic Seas, 1926." Conditions in nearly all Arctic seas were unusually favourable. In the Barents Sea the distribution was about normal, but in August open water reached almost to Franz Josef Land. Eastern Spitsbergen, however, does not appear to have been free of ice, but the west coast was entirely clear during the summer months. The Kara Sea was congested in the south, but vessels got through by using Matochkin Strait. In the Greenland Sea and Denmark Strait conditions were very favourable, and the east coast of Greenland was relatively easy of access. The coasts of Iceland were open throughout the year. On the Newfoundland Banks the amount of ice was below the normal. Ports on the west coast of Greenland were more accessible than usual, and in Hudson Strait there was less ice than has been noted during the past six years. Bering Sea was open so early as the end of June, and there were long stretches of open water along the coasts of Siberia and Alaska during the summer. This is at least the fourth year in which ice conditions generally have been sub-normal and in which no exceptional drift has been reported from any part of Arctic seas.

WATER OF THE DEAD SEA.—The water of the Dead Sea has excited the interest of chemists from early times; Lavoisier, Klapproth, Gay-Lussac, and Gmelin were among the first to analyse it. In the *Comptes-Rendus du Laboratoire Carlsberg*, vol. 16, No. 9, the data obtained from samples collected on an expedition in 1911-1912 are published by R. Koefoed and G. Haugaard, together with a review of former analyses. The late Dr. Koefoed accompanied Dr. Ludwig Brühl's expedition and found evidence of a rise in level of the sea, accompanied by the formation of an upper stratum of water of less density (ca. 1.15) than the water below, which now has roughly the same density (ca. 1.2) as that collected from the surface between 1778 and 1827. The water samples contain chlorides, bromides, and sulphates of sodium, potassium, magnesium, and calcium, and have a total salt content of between 18 per cent. and 32 per cent. At a short distance below the surface the water was found to be nearly devoid of dissolved oxygen, while sulphuretted hydrogen is present in the oxygen-depleted water. The water contains from 0.3 per cent. to 0.5 per cent. of bromine in the form of bromides.

THE NATURE OF LIGHT.—The issue of *Science* for Mar. 18 contains an address by Prof. E. B. Wilson of Harvard to the physical colloquium of the Jefferson Physical Laboratory on some recent speculations on the nature of light. As a foundation for geometrical optics, Prof. Wilson prefers the adaptation of the principle of least action to Fermat's principle suggested by Cox and Hubbard. According to them, the momentum associated with the light quantum $h\nu$ in a medium in which the speed of light is v is $h\nu/v$ and the element of action is $(h\nu/v)ds$. The least action principle then gives $\delta(h\nu/v)ds=0$, that is

$\delta n ds = 0$ where n is the refractive index of the medium. Prof. Wilson contrasts the theories of the constitution of light put forward by Thomson in 1903 and 1924, and doubts the possibility of the Faraday tube, which unites two charges, being the tube of the same name which can be left behind when one of the charges moves too fast for it. He is disposed to regard Bateman's new solution of Maxwell's equations as of the greatest importance, and thinks him the most consistent of the contributors to electromagnetic theory at the present time.

ELECTRO-MECHANICAL OSCILLATORS.—For many years attempts have been made to test telephones by applying to them suitable alternating currents having frequencies within the voice range. A method frequently employed in producing these currents is to utilise the phenomenon known as the 'humming telephone.' It has been known for many years that when a telephone receiver is held in front of its associated transmitter, a humming noise is sometimes heard due to self-generated alternating currents, although there is only a battery in the circuit. This suggested the possibility of obtaining small currents in this way. The humming circuit coupling, however, which is an air column with a diaphragm at each end, was found to be very unstable. This has led to the invention of many kinds of electro-mechanical oscillators, some of which are described by C. R. Moore in the *Bell Laboratories Record* for March. In these devices, generally called 'buzzers,' a purely mechanical element, usually a magnetic bar, one end of which is free to vibrate, is substituted for the acoustical arrangement of the 'hummer.' Although these instruments are quite satisfactory from the economical point of view, they fail to maintain their proper frequency over long periods. In the new device described by the author, both ends of a rectangular bar are free to vibrate, and since the bar is supported at nodal points, almost complete stability is ensured. The driving mechanism consists of a microphone and magnet connected in series with a battery. The mechanical vibrations of the bar are converted into electrical vibrations by microphones placed near the ends of the bar and on opposite sides of it. A very nearly pure wave form is obtained from this arrangement, and its output is more constant than that of any other microphone generator. The device has not yet been perfected, but the results are said to be most encouraging.

OXIDISING AND HÆMATOGENIC POWER OF BOVINE FŒTUS.—The name embryonin is given by Prof. Angelo Pugliese to an extract of all the organs and tissues of the foetus of the ox prepared in such a way that all the active principles retain their powers. The effects produced by the administration of this material to young rats, rabbits, and guinea-pigs have been investigated with the help of various collaborators and are described in the *Rendiconti of the Reale Istituto Lombardo di Scienze e Lettere* for 1926. In all cases the animals treated with embryonin eliminate increased quantities of carbon dioxide per hour per kilogram of body weight. Moreover, the formation of red corpuscles and of hæmoglobin is stimulated and regeneration after bleeding accelerated; the stimulating action is more pronounced on the colouring matter than on the erythrocytes.

ROTATORY POWER AND STRUCTURE OF SUGARS.—We have received from the United States Bureau of Standards a copy of Paper 533, in which the various articles on the relation between rotatory power and structure in the sugar group, published from time to time by C. S. Hudson, have been systematically

arranged and reprinted. The correlation of the rotatory powers of sugars with their structures was begun in 1909 when Hudson put forward his application of Van't Hoff's hypothesis of optical superposition to the sugars and their derivatives. The investigation has since been extended to lactones, amides, phenylhydrazides, etc., and the paper includes a table of the rotations of more than a hundred pure substances which have been measured during the course of this research. The data which are available will be of value to research workers interested in the use of this method of investigation in stereochemistry.

IGNITION OF METHANE BY SPARK DISCHARGE.—When a stream of sparks, too weak to cause ignition, is passed through an explosive gas mixture a slow reaction takes place, and H. F. Coward and E. G. Meiter have published in the February issue of the *Journal of the American Chemical Society* the results of experiments of this kind which they have carried out with methane-air mixtures. The amount of combination brought about by one weak spark is far too small for direct measurement, but by passing a large number of equal sparks at short intervals the extent and nature of the reaction could be determined by careful gas analysis. The products contain much carbon monoxide and some hydrogen, even in the presence of excess of oxygen. From the observed volumes of gas which have to be ignited in order to produce general inflammation, it is concluded that the spark acts almost entirely as a source of thermal energy.

VALVE STEELS.—After discussing the various properties which should be combined in a suitable steel for exhaust valves of aeroplane engines, P. B. Henshaw (*Journal Royal Aeronautical Society*, No. 195, vol. 31, Mar. 1927, p. 187) discusses at some length the properties at high temperatures of various alloy steels. It is of interest that in all the steels which retain their strength well at high temperatures, chromium is an essential constituent. Along with it may be found silicon, cobalt, tungsten, and nickel. The main point of interest in the paper concerns an austenitic nickel-chrome steel containing about 0.45 per cent. carbon, 1.75 per cent. silicon, 12.5 per cent. each of nickel and chromium, and about 2 per cent. of tungsten. Tested in the ordinary way, it has a tensile strength of 24 tons per sq. in. at 800° C. and 12.5 at 950° C., values very much higher than are obtainable from any other steel examined. It does not harden by air cooling from any temperature, but is softer and tougher as the temperature from which it is cooled is raised. It is very resistant to scaling, particularly during long time tests. The expansion which occurs on heating takes place fairly regularly, and no indication of any contraction due to a carbon change is to be noted. The total increase of length is, however, appreciable greater than that found in other valve steels. The best temperature for hot working lies between 1050° and 1100° C., and despite the considerable strength at high temperatures, the forging of the steel is distinctly easier than that of many other alloy steels. It can be drawn into wire cold, but the process is not free from difficulty due to the formation of martensite as a result of the deformation. As with all austenitic steels, machining offers some difficulties, especially sawing and drilling. The cutting angles of the tools should be made more acute and the clearances should be as great as possible. Since from its structure this steel cannot be case-hardened, and since the surfaces do not wear well, protection by a harder steel is often necessary and can be done without undue trouble.

Scientific and Industrial Research.¹

THE Committee of the Privy Council for Scientific and Industrial Research, in presenting its report to Parliament for the year ending July 31, 1926, gives the customary summary of the year's activities of the National Physical Laboratory, the Geological Survey, the nine boards governing researches in specialised fields, and the State-aided industrial research associations. The report also contains a summary of the principal conclusions reached by the Advisory Council, based upon the effects produced during the last ten years by the work of the Department for which it is responsible, and the principles which it is considered should guide further endeavours which are made to assist Great Britain to regain its position as the leading industrial nation of the world.

To the 'general research' programme of the National Physical Laboratory have been added: investigations into the characteristics of insulating materials when subjected to direct and alternating currents, methods of earthing electrical circuits with the object of eliminating danger from leakage currents at high voltages in high-power electrical work, special investigations on the properties of various resistance materials, the effective resistance of large cables of the three-core type, in connexion with which the installation of new high-tension transformers will be invaluable.

Buckley, Collier, and Brookes have devised a method for using the photo-electric cell for colour matching: the cell has been found to be considerably more accurate than the eye. In the Metallurgical Department, considerable progress has been made in research on the alloys of iron, the work being mainly directed to the production of pure iron, free from oxygen, and the constitution of the various iron alloys. The researches have been made more effective by the production in the Department of refractive vessels of pure magnesia and alumina. Increased attention has been given to the fundamental work of the Laboratory on standards. Verification of a number of standards has been made for the Board of Trade, including two new line standards and ninety-six standard weights. Preliminary work on the proposed use of a wave-length of light as the primary standard of length has been completed. An important change has been made in the graduation of scientific glassware, almost all of which is now graded in terms of the millilitre instead of, as formerly, in cubic centimetres. Progress has been made on the work of the international high-temperature scale. In the Photometry Division, work is in progress with the view of the adoption of a black body as a primary standard of light.

The work done by the Laboratory for the boards and committees of the Department, the fighting services and Government departments, continues to increase, while a large number of specific researches are being undertaken for the various State-aided research associations. The researches on the safe loading of underground cables, undertaken for the British Electrical and Allied Industries Research Association, have shown the possibility of immediate economies in the electrical supply industry valued at £250,000 a year. An investigation on the 'spinning' of aeroplanes has been completed. The main features of the effect are now recognised, so that it has been possible definitely to indicate the characteristics of aeroplane

design that are likely to lead to danger from inability to recover from a spin. Wind tunnel experiments on the Cierva 'Autogyro' have been commenced. In the Froude Tank the investigation of the influence of waves on the resistance, propulsion, and pitching of ships has been completed by a second series of model experiments, the results of which throw further light on the causes of loss of speed and the shipping of seas in bad weather. Work on the design of propellers and rudders continues. An interesting piece of work has been commenced on the increase of weight due to water absorption of wooden planking cut from timber treated in different ways.

The work of the Laboratory continues to be hampered by the inadequate accommodation and the difficult conditions under which the work is accomplished. It is hoped that sanction may be given at an early date for the erection of the proposed central block for the physics department; the need of further accommodation in the Electro-Technics Division also remains urgent.

The Geological Survey of Great Britain has continued the work of revising the original maps of British coalfields and industrial areas on the basis of the most recent topographical Ordnance Survey maps on the scale of six inches to one mile. A series of memoirs are being prepared on the sources of underground water in Great Britain. A volume on copper ores has been added to the Special Mineral Reports, which describe the principal metalliferous deposits of Great Britain and its deposits of fireclay, ganister, refractories, and other industrial raw materials of mineral origin. The Survey has also resumed the publication of vertical sections to illustrate the sequence of strata in coalfields. Owing to reductions made in the Government's building programme for the year, no further progress has been made towards the provision of a new building at South Kensington, in spite of the dilapidated and dangerous condition of the Museum of Practical Geology in Jermyn Street.

The work of fuel research has been considerably affected by the difficulties of the coal-mining industry: the development of the physical and chemical survey of the national coal resources in particular has been delayed by the general situation. The most suitable means of carrying into effect the various recommendations of the Royal Commission on the coal industry are under consideration, but it is pointed out that the financial resources of the Department cannot meet the increased expenditure which would be entailed by the full programme of research work outlined by the Commission relative to the winning and marketing of coal, which in any case falls outside the present activities of the fuel research division. Work on high-temperature carbonisation continues. The report on the enrichment of coal gas by the injection of oil into vertical retorts during carbonisation has aroused considerable interest in the gas industry and may have important results. Experiments with various types of retorts in connexion with the problem of low-temperature carbonisation continue. Distinct progress has been made with the work on the production of power alcohol from cellulosic materials by bacteriological processes. The by-product of this research is the production from vegetable material, such as straw, of a binding material for the manufacture of briquettes. It is not mentioned in the report, but this may prove to be of the greatest importance in connexion with the development of the Nigerian coalfields, which produce a friable coal.

¹ Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1925-26 (Cmd. 2782.) Pp. iv+178. (London: H.M. Stationery Office, 1927.) 8s. net.

It is interesting to note that an agreement has been entered into with the interests controlling the Bergius process by which the Department obtains full information as to the work on British coals being carried out either in Germany or in Great Britain, and a voice in directing the investigations. Other investigations include an inquiry into the spontaneous combustion of coal in ships, an investigation into slow combustion in boiler furnaces, and a search for suitable metals for the construction of low-temperature retorts.

The year has been remarkable for the increase in the demands from industry for the investigation of special problems in connexion with the preservation and the storage of food. Much information is being accumulated regarding the way in which water is held by the proteins of the flesh of beef and the effect of cold upon the intimate chemical structure of the muscle substance, but it has not yet been found possible to apply the method of very rapid freezing to masses of beef so large as a quarter, or even a joint. No definite programme of work on fish was undertaken during the year, because it had been found that work on fish preservation at an inland station is too wasteful of time and effort. The report emphasises the need for a small research station at a fishing port, and it is understood that arrangements have already been made in connexion with the Empire Marketing Board to acquire a suitable site. The new laboratory at Covent Garden is doing useful work in connexion with the conditions of produce after transport and storage, and the diagnosis of the various types of wastage and depreciation found. Two inquiries of general interest were undertaken at the request of shipping companies: the first was concerned with the leakage of air from one storage chamber to another, resulting, for example, in the contamination of eggs or butter by food odours; the second was concerned with the best design for refrigerated provision stores on passenger boats and with the method of stowage and the temperature to be used for foodstuffs. A report has been published on gas storage, marking an end of a definite stage in this investigation which covers the results of laboratory experiments and storage trials extending over a period of six years.

Many interesting topics are dealt with in the account of investigations given in the various sections under the co-ordinated research boards, among which may be mentioned: stresses in railway bridges; work at the Royal Naval Cordite Factory under Dr. A. C. Thayssen on the deterioration of fabrics by micro-organisms; the development of apparatus for the absolute measurement of sound intensity; the utility of artichokes as a raw material for the manufacture of alcohol and good quality cellulose; the use of substances derived from low-temperature tars and minor metals in chemotherapy; stone preservation and building research generally; and the deterioration and restoration of museum exhibits. An interesting reference is made to the examination of the fatty substance, apparently a cosmetic, contained in a calcite jar recovered from the tomb of Tut-ankh-amen. The fat, which had been sealed up for 3000 years, was apparently of animal origin; a small quantity of resinous and odoriferous substances had originally been added to it.

While the report gives an encouraging account of the researches being undertaken in the State laboratories under the Department of Scientific and Industrial Research and those under the supervision of the various co-ordinating research boards and in university laboratories, the same note of optimism is not present with regard to the industrial research associations,

and very little information is available in the report regarding the research activities of these bodies. The Committee of Council states that it has adhered to the policy of continuing to assist for a second five years those associations which have done good work and show promise of becoming self-supporting when normal conditions are restored. During the year the work of the British Motor-Cycle, and Cycle Car Research Association, the British Silk Research Association, and the British Cast Iron Research Association, having reached the end of their initial five-year grant periods, came under review. In each instance diminishing block grants have been made for a further period of five years. The British Leather Manufacturers' Research Association has been given a grant on the £ for £ basis for a period of two years. The Committee did not feel justified in giving further aid to the Scottish Shale Oil Scientific and Industrial Research Association, which had not agreed to the recommendations made for the vigorous prosecution of research on a considerable scale involving a considerable increase of expenditure. Further assistance has been given to the British Motor and Allied Industries Research Association, the British Cutlery Research Association, and the British Refractories Research Association. The appeal to the industry for the necessary contributions for the British Empire Sugar Research Association having been unsuccessful, the Committee has not authorised any further grant assistance being given.

The Advisory Council expresses the view that industry is not as a whole sufficiently alive to the need of scientific research or inclined to give sufficient recognition to the work which is being done by the various co-operative research associations. The electrical industry, for example, not only owes its origin to pure research, but is assisted even now more than any other industry by researches carried out in universities and in Government establishments. The work carried out under the direction of the British Electrical and Allied Industries Research Association is of sufficient value to the electrical industry to call for a far greater effort on the part of the supply undertakings to maintain the Association on an adequate financial basis. Further direct support from the taxpayer after the present grant period, which ends in September 1930, cannot be looked for. "We recognise," say the Advisory Council, "the especial difficulties of the time; but nevertheless we must emphatically record our opinion, which we feel assured is shared by all progressive sections of British industry, that essential though a steady scientific policy always is, its importance increases in times of adversity. When we reflect how trivial in relation to the value of the total output of an industry is the expenditure needed to produce by co-operative research results of direct industrial importance, we cannot believe that private enterprise will lack the courage and foresight to maintain on an adequate basis these associations which have already shown their actual and potential value."

During the year under review recommendations have been made by the Advisory Council on the programme for research for 1926-27, for which estimates have been drawn up amounting to £442,877, as compared with £380,263 for 1925-26 and £328,281 for 1924-25, or a slightly greater percentage increase for the current year than for last year. The Empire Marketing Board has promised a grant-in-aid of £25,000 for capital expenditure and £5000 as a first annual grant for current expenses of research for the extension of the work of the Food Investigation Board.

Intensification of the Latent (or Developable) Image.

IT was shown recently by Wightman, Trivelli, and Sheppard (of the Research Laboratory of the Eastman Kodak Company) that when single-layer plates were given a very short exposure to light and then treated with a very dilute solution of hydrogen peroxide, that the resulting developability was greater than the sum of the two separate effects. It was suggested that a part of the light-exposure effect was undevelopable, and that the peroxide, besides producing its own developable image, carried over the undevelopable part of the other into the developable condition. This is the phenomenon that is called the "intensification of the latent image."

Messrs. Wightman and Quirk (*Jour. Franklin Institute*, Feb. 1927) have extended this work, using ordinary plates and films. Their method is to give a graduated exposure and to divide the plate into three strips—(1) developed straight away, (2) developed after soaking in a very dilute (0.004 to 0.016 per cent.) solution of hydrogen peroxide, and (3) exactly like (2), but using plain water. The concentration of the peroxide and the time of treatment were varied, and silver nitrate was used instead of the peroxide. They find that hydrogen peroxide and silver nitrate, and perhaps some other noble metal salts, acting on a photographic plate after exposure and before development, increase the developability of the light-exposed portion above its normal developability and in a greater proportion than the unexposed part. The effect is approximately equivalent in degree to that produced by a brief flash exposure of the plate to light before or after the principal exposure. Other circumstances being equal, the effect is smaller on plates of medium speed and not detectable at all on 'process' (slow) plates or plates that have been desensitised by chromic acid, unless the concentration of the hydrogen peroxide or the time of treatment is considerably increased. By this method it is possible to detect one part of hydrogen peroxide in ten million parts of water to within 20 or 30 per cent. It is considered that the process is not suitable for general photographic work because it needs too much care in its application.

University and Educational Intelligence.

LONDON.—The following courses of free public lectures are announced:—

At University College, at 4.30, on May 3, 4, and 6, "Sensation and the Sensory Pathway," by Prof. J. S. B. Stopford; at King's College, at 5, on May 3, 10, 17, and 24, "Autonomic Nervous System," by Prof. R. J. S. McDowall. At the Imperial College of Science—Royal School of Mines, at 5.30, on May 10, 17, and 24, "Problems of the Respiration of Plants," by Dr. F. F. Blackman. No tickets will be required.

THE Rev. L. Van Vestraut, who has for several years been chief assistant in the Testing Department at Faraday House Electrical Engineering College, has been appointed Registrar. Mr. Vestraut is an old student of the College, and was head student of his year. Mr. F. A. Bell has been appointed Secretary of the College.

THE New Education Fellowship will hold its fourth international conference at Locarno on Aug. 3-15 next. The general theme is to be the true meaning of freedom in education; Prof. Pierre Bovet of Geneva will be president. The freedom desired is that which comes from inner control, not external restraint, and the conference will seek to discover the basic principles underlying the many novel systems such as the

methods called Winnetka, Project, Mackinder, Decroly, Montessori, Dalton, and Howard. Secondary schools, the psychological freedom of the teacher, and local geology are also included in the programme. Several well-known names are on the list of expected speakers. The Fellowship now has associated magazines in six different countries. For England, inquiries should be directed to the secretaries, New Education Fellowship, 11 Tavistock Square, London, W.C.1.

THE Carnegie Trust for the Universities of Scotland has completed a quarter of a century's beneficent labour on behalf of Scottish education. Its activities have followed three lines: grants to the universities and extra-mural institutions, endowment of research, and assistance to students. The first are distributed in quinquennial periods, and for the years 1925-30, the twenty-fifth annual report states, there have been allocated for libraries £24,225, for buildings and permanent equipment £196,500, and for the endowment of teaching and other general purposes £10,500. Research endowments for 1925-26 claimed £17,130, and 4711 students received assistance in the payment of class fees to the extent of £57,212. Apart from the encouragement given to the acquirement of knowledge in the class-room and laboratory, the Carnegie Trust most influences science through its research endowments, a very small minority of which are devoted to history and modern languages and literature. A result is apparent in the long list of more than forty contributions to scientific knowledge which have been published during the course of the year by fellows, scholars, and grantees. Three years ago a scheme of 'teaching fellowships' was instituted, which allowed the annual award of grants to university lecturers and assistants, on condition that not less than one-half of their time was devoted to research. This scheme seems to have borne excellent results, and is to be continued in its present form for another trial year, but one of the referees directs attention to the danger that an excessive amount of teaching may be exacted from the recipient of the grant.

IN the report for 1926 of the Association of Women Science Teachers, Miss R. Stern has an interesting and valuable paper on the teaching of chemistry in the middle school. She urges that, in the practical work, each experiment should be of such a nature that it brings about a definite result, and that each group of experiments should lead to a definite conclusion. Whenever possible these experiments should be quantitative and require the setting up of apparatus which is not too difficult for the beginner, and they should be of such a nature that faulty manipulation leads to failure. At the beginning of a chemistry course an ordinary text-book is not advisable, as the results of the experiments are given, and this may prevent the class from being conscientious or even truthful. Miss Stern then describes in detail two courses which she has successfully employed. The basis of the first was the preparation of all substances used from materials met with in common life, e.g. sand, lime, slate, bricks, etc. Alkalis were prepared by burning beetroot and lixiviating the residue, and altogether the course appears to be a very attractive one. The second scheme is historical, and the author says that she has found this to be more satisfactory in practice than the first, since the historical development of a science is the natural development and is, above all things, a building up from the foundations. It enables the class to realise how discoveries have been made, and teaches them clearly that one wrong step may lead to hopeless confusion. Teachers will find Miss Stern's detailed syllabus of the historical course extremely suggestive and useful; it has evidently been carefully thought out and patiently tested in the school.

Calendar of Discovery and Invention.

April 25, 1839.—Many objections were raised against building ships of iron, but the two real difficulties arose through the disturbance of the compass and the fouling of the hulls. Airy did more than any one to solve the compass problem, but in his autobiography is the entry, "I had in this year (1839) a great deal of troublesome and on the whole unpleasant correspondence with the Admiralty about the correction of the compass in iron ships. I naturally expected some acknowledgment of an important service rendered to Navigation: but the Admiralty peremptorily refused it. . . . The general success of the undertaking soon became notorious, and (as I understand) led immediately to extensive building of iron ships." The vessels Airy used in his experiments were the *Rainbow* and *Ironsides*, and his results were published in a paper to the Royal Society on April 25, 1839.

April 25, 1848.—So far back as 1746 the Government offered a reward of £20,000 for the discovery of a passage by sea between the Atlantic and Pacific north of 52° N., and many explorers sought for the route. Among these was the heroic Franklin. He left England with the *Erebus* and *Terror* in 1845 with 129 men, but none survived. In 1859 relics of the expedition were discovered, and among them this entry, "April 25, 1848: the ships were deserted on April 22nd, having been in the ice since September 12th, 1846. Sir John Franklin died June 11th, 1847, and the total loss to this date has been nine officers and fifteen men. The rest (105 in number) landed here and start to-morrow for the Great Fish River."

April 27, 1857.—The earliest photographs of stars were obtained by Whipple at Cambridge, Mass., in 1850, but double-star photography was inaugurated by G. P. Bond, who on April 27, 1857, with an exposure of eight seconds, obtained an impression of Mizar, the middle star in the handle of the Plough.

April 27, 1888.—In a lecture at the Royal Institution on this day, Wimshurst described his famous influence machine. Of this machine it was said it "completely revolutionised the science of static electricity, for there had never been before its introduction a machine for the production of static charges which was not the subservient slave of the hygrometric condition of the atmosphere." Wimshurst constructed more than ninety such machines.

April 27, 1893.—Thirty-four years ago, Rudolph Diesel explained at Augsburg his ideas on the famous heat engine now bearing his name. The Diesel engine was the result of theoretical inquiries which he published under the title, "The Theory and Construction of a Rational Heat Motor."

April 29, 1820.—The founder of the rubber industry in England, Thomas Hancock, took out his first patent on April 29, 1820, for "an improvement on the application of a certain material to certain articles of dress and other articles that the same may be rendered more elastic." It was, however, not until twenty-three years later, on Nov. 21, 1843, that he patented 'vulcanised' rubber, the term 'vulcanisation' being suggested by his partner Brockedon,

April 30, 1799.—A century ago the most important chemical factory in the world was that of Charles Tennant and Co. at St. Rollox, Glasgow. In 1788, Tennant had discovered a method of controlling chlorine by the admixture of lime, and on April 30, 1799, he patented his method of producing chloride of lime or bleaching powder, a substance for which at first he obtained £140 a ton. E. C. S.

Societies and Academies.

LONDON.

Linnean Society, Mar. 17.—E. M. Marsden-Jones and W. B. Turrill: An improved herbarium method for geneticists, ecologists, and taxonomists. The method has been used at Kew for some years, and, with minor modifications, is capable of very wide application. The process consists in the sticking down of the specimens in the living condition. The best results have been obtained with paste, not with gum or glue, 'Gloy' being the best so far tested. A sheet of paper or card is brushed over with a thin layer of the paste, and the specimens placed on this. They are dabbed down and the sheet is placed in a press and considerable pressure applied. It is advisable to look at the preparations within a few hours, and remove any excess paste. After a few days the specimens are dried; they retain their shape, and sometimes their colour, indefinitely. With some plants, ironing through blotting-paper with a hot iron gives excellent results.—Miss F. Haworth: Lichen dyes. *Parmelia saxatilis* (gathered preferably after a wet day) and *P. omphalodes* are used in the preparation of Harris tweed, and give a characteristic smell to the cloth. Three methods of dyeing are used: (1) Boiling the lichen and wool together; (2) soaking in ammonia for a week; (3) boiling with ammonia for about two hours until mucilaginous, folding dye and cloth alternately and covering with rain water with a little alum, boiling for twenty minutes, and then washing the cloth in cold water. Generally the best results are obtained where numerous soredia are present. Rock lichens give the best dyes, those species with a large flat thallus rarely producing a permanent dye, though *Peltigera canina* gives a yellow colour with cotton.—F. E. Fritch: Heath-association on Hindhead Common. The relative grouping of the different species varies considerably with the time since the last fire, with the aspect, and with soil features. The character of the vegetation shortly after a fire depends upon the size of the growth that was burned, but ultimately *Calluna* becomes completely dominant and more or less completely hides the codominant, but largely prostrate, *Ulex nanus*. On slopes facing south *Erica cinerea* may become a temporary dominant for some years. Fires cause little ultimate change. Plants like *Pteridium* and *Molinia* may exhibit a limited increase of area in the first year after a fire, but do not advance after the vegetation has closed up.

Geological Society, Mar. 23.—E. S. Cobbold: The stratigraphy and geological structure of the Cambrian area of Comley (Shropshire). The exact positions of the excavations made by the author since 1906 are recorded, and the stratigraphy and tectonics as revealed by them and by the surface-features described. The folding and faulting of the Cambrian fall naturally into four groups: (1) post-Mesonacidian and pre-Paradoxidean, general direction unknown; (2) post-Paradoxidean and pre-Caradocian, general direction north-north-west to south-south-east; (3) post-Caradocian and pre-Silurian, general direction north-east to south-west, all the result of compressive forces; and (4) post-Silurian, tensional stresses responsible for the Church Stretton Fault. The facts detailed indicate seven diastrophic phases of various intensities. Special attention is given to the complicated Dairy Hill area, where recent work has fully substantiated the inference previously drawn from the Comley breccia-bed, that a peak or promontory of Lower Cambrian sandstone remained above water during the accumulations of some 300 feet or more of strata of the Paradoxidesgroomi zone.

EDINBURGH.

Royal Society, Mar. 28.—W. Peddie: Magnetism and temperature in crystals. In earlier papers the development of expressions for the mutual actions of the magnetic molecules, which Weber postulated, were given, subject to the condition that temperature motions of the molecules were neglected. These are now taken into account. An equation of thermomagnetic state is deduced, and subject to the choice of a unit of energy variable with the direction of magnetisation in the crystal, it may be put into a form similar to the thermomechanical equation of state of Van der Waals. Like that equation, it may be put into a form which is the same for any crystal, magnetised in any direction, when the magnetic field, the magnetic intensity, and the temperature are expressed as multiples of the corresponding 'critical' quantities.—Miss W. M. Smith: The after-images of coloured light. With stimulation by red, green, and blue lights, no observable fundamental difference was noted in the case of the two latter, possibly because the blue light contained a considerable admixture of green. The succession of colours seen in the after-images can be represented as originating in three independent colour sensations, red, green, and blue respectively. These can be regarded as varying with time in accordance with a simple harmonic law involving logarithmically decaying amplitudes.—H. H. Read: The igneous and metamorphic history of Cromar, Deeside, Aberdeenshire. The three phases of igneous activity of this region are (1) the geosynclinal phase, with the intrusion of gabbro sills of pre-metamorphism age; (2) the movement phase, consisting of the injection of acid igneous material during the later stages of the movement-period; and (3) the post-movement phase, exemplified by the intrusion of cross-cutting granites entirely later than the crystal movements. The chief rock of the movement phase is oligoclase-biotite-gneiss considered to result from the union of acid soda-rich injected material with sedimentary pelitic schists. Injection of similar magnetic material into hornblende-schists resulted in the formation of pseudo-dioritic rocks. Post-consolidation phenomena of this injection are due to the action of alkaline solutions producing myrmekite, shimmer aggregates, etc.—A. Calder: Rôle of interbreeding in the development of the Clydesdale breed of horses. Using Sewall Wright's coefficient of inbreeding, it is found that during the early history of the breed very little inbreeding has been practised. A method is outlined by which a measure can be obtained of the contribution of any particular sire to the average percentage of inbreeding for the breed, the degree of concentration of his blood in animals inbred to him, and the rate at which his blood is diffused through the breed. The homozygosity of the Clydesdale breed, relative to the condition existing in the foundation stock, has been increased by 6.25 per cent. by inbreeding alone.—Y. Tamura: The effects of implantation upon ovarian grafts in the male mouse. Implantation of ovary on to the surface of the kidney of the male demonstrated that in the majority of cases the graft survives and retains the typical ovarian structure. If the germinal epithelium is unimpaired, proliferation occurs and continues until the graft has attained the stage at which it was at the time of operation. The original follicles undergo degeneration.

MANCHESTER.

Literary and Philosophical Society, Mar. 8.—E. Butterworth: A new method of electro-conductivity titration. A continuous reading method of con-

ductivity titration employing thermionic valves is described. The apparatus comprises, in its simplest form, two valves, one arranged as an audio-frequency oscillator giving approximately a pure wave form, the other arranged as a rectifier. The titration cell is included in the oscillator circuit in such a manner as to give a sensibly constant peak value of alternating current with appreciable variation of resistance of the cell. The voltage across the cell is then measured by means of the rectifier after the manner of the Moullin voltmeter. The amount of standard substance added is plotted against the anode current of the rectifier. 'Voltage' effects at the electrodes of the cell are excluded. The main advantages of the method lie in the speed and ease of working; the sensitivity can be readily varied within wide limits.

SHEFFIELD.

Society of Glass Technology (Birmingham meeting), Mar. 16.—Th. Teisen: Some further developments in recuperative glass furnaces. A new design of recuperator was described in which there is an increase in efficiency: (1) the greater heating surface ensures a higher temperature of the secondary air; (2) the reduction in space results in smaller radiation and convection losses. With the development of the recuperative furnace there has been a demand for large units. When built on the 2-recuperator principle the design outlined has certain drawbacks, to overcome which a new design has been developed on the 'tetra' recuperative principle. This design has four recuperators instead of two, arranged symmetrically in each corner of the base. A simple application of a patent system of oil firing was described. Furnaces working on this system can be fired either with oil alone or with coal or producer gas in the ordinary way, combined with oil as auxiliary fuel.—Violet Dimbleby, S. English, W. E. S. Turner, and F. Winks: The properties of some soda-lead oxide glasses. Successive replacement of soda by lead oxide gives glasses with progressively decreasing annealing temperature and thermal expansion. The action of boiling water on the glasses has been investigated and the percentage loss in weight determined; lead oxide glasses are better than those containing lime, while those containing barium oxide are the worst of the series. An important new set of factors has been determined by which the thermal expansion of lead oxide and barium oxide glasses can be calculated. The factors originally proposed by Winkelmann and Schott in 1895 need revision, and the following are the new values: SiO_2 , 0.15; ZnO , 0.21; Al_2O_3 , 0.52; ZrO_2 , 0.69; MgO , 1.35; PbO , 3.18; CaO , 4.89; BaO , 5.2; Na_2O , 12.69; K_2O , 11.7.

PARIS.

Academy of Sciences, Mar. 14.—The president announced the death of Daniel Berthelot, member of the Academy.—Pierre Termier: That the crystallophyllian series of the Vanoise and of Mont-Pourri (Savoy Alps) is Permian or Carboniferous. In 1861, Lachat suggested that the felspar and chlorite rocks of Modane were metamorphosed coal measures, but the view was not accepted. As the result of recent observations, the author considers it definitely proved that the metamorphic strata of Vanoise, Becca-Motta, Aiguille-du-Midi, and Mont-Pourri are of the Permian or Carboniferous age.—Gabriel Bertrand and J. Perietzeanu: The presence of sodium in plants. It is pointed out that indirect methods for determining sodium in the presence of preponderating proportions of potassium are unsatisfactory, and for this reason a direct method has been used, the precipitation of the triple acetate of uranyl, magnesium,

and sodium. By this reaction quantities of sodium between 0.25 mgm. and 2.5 mgm. can be determined, even in the presence of relatively large quantities of potassium. All the plants examined, thirty-five in number, contained sodium in amounts varying from 0.0017 per cent. to 3.507 per cent. of the dry material.—A. Th. Schloesing and Désiré Leroux: The influence of drying and warming soils on the proportion of phosphoric acid soluble in water. Confirmation and extension of the work of Lebediantzeff on the same subject.—E. Mathias: Contribution to the study of fulminating material (lightning). Is it hot or cold?—E. Bataillon: The origin of the amphiaser of segmentation in the parthenogenesis of the batrachians, and the problem of regulation.—Bertrand Gambier: Surfaces having a ds^2 of Liouville and their closed geodesics.—Georges Bouligand: The principle of the positive singularities of Picard.—Paul Lévy: The iteration of functions and the idea of regular growth.—D. V. Jonesco: A class of functional equations.—Huguenard, A. Magnan, and A. Planiol: A monograph for the measurement of rapidly varying pressures and an indicator for the study of high-velocity thermal machines.—Ernest Esclançon: The stability of projectiles in their movement round their centre of gravity.—V. Nechville: Star streams and the solar apex.—Raymond Chevalier: A new ferromagnetic ferric oxide. A study of the magnetic properties of ferric oxides produced by the action of hydrogen peroxide and varying quantities of caustic soda on ferrous sulphate solutions. The effects of varying temperatures were also studied.—Henri Gutton and Jean Clément: The propagation of electromagnetic waves round the earth.—Jean Cabannes: The distribution of energy on thermic elastic waves in the midst of a fluid and the diffusion of light by liquids.—Albert Pérard: New study of some radiations of mercury, krypton, and xenon from the point of view of their meteorological applications. The results of a detailed study of the following lines are given: Mercury, 435.8, 491.6, 546.1, 577.0, and 579.1; krypton, 557.0, 587.1; xenon, 462.4, 467.1, 473.4.—Emile Rousseau: A special action of the radiations of the mercury arc.—Pierre Brun: The surface tensions of water-alcohol mixtures. Diagrams are given embodying the experimental results for the surface tensions of water—ethyl alcohol—propyl alcohol and water—ethyl alcohol—isoamyl alcohol mixtures.—G. Denigès: The preparation and composition of crystallised blue complex compounds of phosphorus and molybdic acid and of arsenic and molybdic acid.—N. Maxim: The action of organo-magnesium compounds on the N-tetraphenylphthalimides.—P. Idrac and R. Bureau: Experiments on the propagation of radiotelegraphic waves at high altitudes.—L. Eblé and J. Itié: The values of the magnetic elements at the Station of Val-Joyeux (Seine-et-Oise) on Jan. 1, 1927.—M. and Mme. A. Chauchard: Researches on the cerebral localisations in fishes.—Philippe Fabre: Neuro-muscular stimulation by progressive currents in man.—J. Risler and Foveau de Courmelles: The radiant shock.—Charles Pérez: The postlarval evolution of the pleopods in Galathea.—A. Paillot: Experimental *gattine* (silk-worm disease) in silk worms.—René Fabre and Henri Simonnet: Contribution to the study of hæmolyxis by the photosensitising action of hæmatoporphyrin.

GENEVA.

Physical and Natural History Society, Feb. 17.—Paul Langevin: The equilibrium between matter and radiation. The author gives expressions for the number of light quanta the energy of which is comprised between given limits, both as in classical

statistics and according to the more recent statistical theories of Bose-Einstein and of Pauli. At high temperatures all the formulæ approach the same expression which, completed by considerations borrowed from the theory of general relativity, defines the conditions of the genesis of electrons and protons in the interior of the giant stars.—Th. Posternak: A new reaction of pyruvic acid. The liquid to be examined is diluted with its own volume of concentrated hydrochloric acid. Some crystals of phloroglucemol are added and the whole maintained at the boiling-point for three or four minutes. If the colour (or precipitate, according to the quantity of pyruvic acid present) turns green after neutralisation with sodium carbonate, the reaction is positive.—P. Dive: The impossibility of an ellipsoidal stratification of the planets. The author establishes by calculation the impossibility of conceiving the planets as constituted of ellipsoidal layers, if it is admitted that gravity is normal to surfaces of equal density.—Rolin Wavre: The stratification of a heterogeneous fluid mass in rotation. The author demonstrates the three following propositions: (1) Surfaces of equal density tend towards the ellipsoidal form as the centre is approached, (2) if the surfaces were homothetic they will be ellipsoidal, (3) and since, according to Dive, ellipsoidal stratification is impossible, a stratification in homothetic surfaces of a heterogeneous fluid is impossible.—E. Guénot and O. Schotté: Graft of a regenerated member and induced differentiation. A regenerated member removed from the foot of 45 days' growth and showing first indications of digits, was transferred to the back of the tail of the same Triton. The subsequent development gave a tail. This regenerated portion transplanted with a section of tissue from the base of the foot on to the tail, however, continued to develop in the form of a foot. Hence it is the base which gives the morphogenetic impulse to the regenerating tissue.—E. Pittard: The cranial capacity of the Boschiman Hottentots. Measurements made on 101 skulls lent to the author by the Cape Town Museum have given different averages from those of Broca, namely, masculine skulls 1395.3 c.c. (Broca 1317); feminine skulls 1268 c.c. (Broca 1253).

ROME.

Royal National Academy of the Lincei, Jan. 16.—V. Volterra: Laws of biological fluctuations.—O. M. Corbino: The Volta effect and the mechanism of the voltaic pile. The Volta effect is considered, and its bearings on the actions of the ionised gas cell, the mechanical cell, and the electrolytic cell are discussed.—O. M. Corbino: The electronic theory of the voltaic cell. Since the Volta effect exists in a vacuum and therefore independently of chemical action, the metallic couple, such as zinc-copper, constitutes a natural means for producing an electrostatic field, even in a space of large dimensions. Like a permanent magnet, such a couple creates round itself a magnetic field. The energy of this field is of purely physical origin and is derived from the varying energy of linking of the conduction electrons to the different metals. In the ionisation cell obtained by immersing a metallic couple in an ionised gas, the electrostatic field due to the Volta effect produces a permanent current without furnishing energy, which is supplied from outside. In the hydro-electric cell of the Daniell type the Volta effect is more important; the energy is produced by virtue of the formation of neutral copper and the destruction of neutral zinc, the greater part of the e.m.f. being formed at the contact between the two metals.—L. Cambi and Ada Clerici: Ferroso-ferric cyanides. Atomic groupings of the form $[\text{Fe}(\text{CN})_5\text{X}]$ are able to exert chromogenic

functions analogous to those of the group $[\text{Fe}(\text{CN})_6]^-$; that is, the groups contained in the ferrous-ferric cyanides may preserve the co-ordinative distribution of the complex ions of the alkaline salts from which they are derived. The presence alone of ferrous and ferric ions is not sufficient for the formation of blue cyanides.—E. Bompiani: Analytical and geometrical investigations on Laplace's equation.—M. Picone: Metaharmonic functions.—F. Tricomi: Limitations of the solutions of certain equations with partial derivatives.—E. P. Lane: Quadrics having for generatrices the tangents asymptotic to a point of a surface.—N. Spampinato: The problem of complex multiplication for any pure body of Abelian functions.—G. Vranceanu: Geodetic stability.—U. Barbieri: Determination of astronomical latitude carried out at Andrate in August 1926. The geodetic and astronomical latitudes of Andrate are respectively $45^\circ 31' 38.9''$ and $45^\circ 31' 9.8''$; and since those of Mondovì were found to be $44^\circ 23' 24.3''$ and $44^\circ 23' 42.48''$, the geodetic and astronomical amplitudes between the two points are $1^\circ 8' 14.6''$ and $1^\circ 7' 27.3''$ respectively.—N. Siracusano: A noteworthy deduction from Bohr's theory. On the assumption that the only atomic model is that of Bohr, it is shown that the natural chemical elements cannot number 138.—L. Mazza: Products formed during the action of lead accumulators (ii). X-ray photographic results show that the paste of the positive plates of lead accumulators consists almost solely of lead peroxide in a normally-charged or greatly overcharged cell and of mixtures of the peroxide and sulphate in cells either partially or completely discharged.—A. Bartorelli: A demonstration of the interdependence between Curie's and Häy's laws. Objections are raised to Viola's proof (1918) that it is possible to pass from Curie's law to that of Häy.—U. Panichi: Crystal lattices. Molecular space and atomic number. With the halides of the alkali metals the molecular space increases with the molecular number. For analogous compounds having the same molecular number, the molecular space increases as the ratio of the atomic number of the metal to that of the non-metal diminishes. When this ratio is constant or almost so for non-analogous compounds, that is, those having non-isovalent metals, the molecular space diminishes as the valency increases.—C. Jucci: Maternal and paternal heredity in the capacity for larval development of the reciprocal crosses between two races of silkworms. The results of crossing white with mottled silkworms show that these two characters have a definite value or hereditary power which does not change when the sense of the crossing is inverted. The influence of the factor is immediate when its incidence is maternal but slow when it is supplied by the paternal parent.

Official Publications Received.

BRITISH.

Home Office. Judicial Statistics, England and Wales, 1925. Criminal Statistics: Statistics relating to Criminal Proceedings, Police, Coroners, Prisons and Criminal Lunatics for the Year 1925. (Cmd. 2811.) Pp. iv+222. (London: H. M. Stationery Office.) 4s. net.

Journal of the Chemical Society: containing Papers communicated to the Society. March. Pp. viii+iii+529-700. (London: Gurney and Jackson.)

University College of Wales, Aberystwyth. Welsh Plant Breeding Station. The Annual Complex and the Pasture Complex. (Series H, No. 5.) Pp. 54. (Aberystwyth.) 2s. 6d.

University College of Wales, Aberystwyth: Agricultural Department. Advisory Bulletin, No. 2: The Nutritive Value of Grasses, as Pasture, Hay and Aftermath, as shown by their Chemical Composition. By T. W. Fagan. Pp. 23. (Aberystwyth.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachin (Cutch). By L. F. Spath. Pp. iii+64+7 plates. (Calcutta: Government of India Central Publication Branch.) 4.12 rupees; 8s.

County Library Conference, November 18th and 19th, 1926, held in the First Avenue Hotel, High Holborn, London. W.C. Report of the Proceedings. Pp. 121. (Dunfermline: Carnegie United Kingdom Trust.)

Some Impressions of the Public Library System of the United States of America. Pp. 90. (Dunfermline: Carnegie United Kingdom Trust.)

Union of South Africa: Department of Agriculture. 11th and 12th Reports of the Director of Veterinary Education and Research. Part 2, January 1927. Pp. iii+819-181+9 plates. (Pretoria: Government Printing and Stationery Office.) 10s.

The Wellcome Historical Medical Museum, 54A Wigmore Street, London. Pp. 118. (London: The Wellcome Foundation, Ltd.)

Lister Centenary Exhibition at the Wellcome Historical Medical Museum. Handbook, 1927. Pp. 216. (London: The Wellcome Foundation, Ltd.)

Transactions of the Optical Society. Vol. 28, No. 2. Pp. ii+45-116. (London: Optical Society, Imperial College of Science.)

Board of Education. Second Report of the Standing Joint Committee representative of Local Education Authorities and Associations of Teachers on Scales of Salaries for Teachers in Technical and Art Schools in which the Local Educational Authorities accept Responsibility for the Salary Scales. England and Wales, February 1927. Pp. 30. (London: H. M. Stationery Office.) 3d. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 32: The Correlation of Nutritive Value with Dry Matter Content of Pastures. By E. J. Sheehy. Pp. 389-398. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Imperial Institute. Annual Report, 1926, by the Director, Lt.-Gen. Sir William Furse, to the Board of Governors. Pp. iii+46. (London.)

Tanganyika Territory. Report of the Department of Agriculture for the Year ending 31st March 1926. Pp. 37. (Dar es Salaam: Government Printer.)

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1926; Prepared for the Annual General Meeting, to be held on Friday, April 29th 1927, at 4 p.m. Pp. 75. (London.)

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 50. Edited by Prof. Walter Howchin, assisted by Arthur M. Lea. Pp. iii+350+53 plates. (Adelaide.) 21s.

Year-Book of the Department of Agriculture, Ceylon, 1927. Pp. ii+66+20 plates. (Peradeniya: Department of Agriculture.)

Melbourne Astrographic Catalogue 1900.0. Vol. 1: Zones -65° and -66°. Rectangular Co-ordinates and Diameters of Star Images, from Photographs taken and measured under the Direction of R. L. J. Ellery and Pietro Baracchi; revised and prepared for Publication under the Supervision of Dr. J. M. Baldwin. Pp. xxx+334. (Melbourne: H. J. Green.)

FOREIGN.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 60. The Development of the Egyptian Cotton Plant. By M. A. Bailey and T. Trought. Pp. ii+46+18 plates. (Cairo: Government Publications Office.) 5 P.T.

Actes de la Société Helvétique des Sciences Naturelles. 107^e Session annuelle du 30 août au 1^{er} septembre 1926 à Fribourg. Pp. 146+266+22. (Aarau: H. R. Sauerländer et Cie.)

United States Department of Agriculture. Department Bulletin No. 1429: The Parasites of *Popillia japonica* in Japan and Chosen (Korea), and their Introduction into the United States. By Curtis P. Clausen and J. L. King and Cho Teranishi. Pp. 56. 15 cents. Department Bulletin No. 1453: The Cheese Skipper as a Pest in Cured Meats. By Perez Simmons. Pp. 56. 15 cents. (Washington, D.C.: Government Printing Office.)

University of California Publications in American Archaeology and Ethnology. Vol. 21, No. 8: The Uhle Collections from Nieveria. By A. H. Gayton. Pp. 305-329+plates 91-97. 35 cents. Vol. 24, No. 1: The Uhle Pottery Collections from Nazca. By A. H. Gayton and A. L. Kroeber. Pp. 46+21 plates. 60 cents. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.)

Proceedings of the United States National Museum. Vol. 69, Art. 10: The North American Two-Winged Flies of the Family Simuliidae. By Harrison G. Dyar and Raymond C. Shannon. (No. 2686.) Pp. 54+7 plates. Vol. 70, Art. 12: Tanaodon, a new Molluscan Genus from the Middle Devonian of China. By Edwin Kirk. (No. 2661.) Pp. 4+1 plate. Vol. 70, Art. 17: Description of a new Dragon Fly from Lower Siam belonging to the Genus *Urothemis*. By F. F. Laidlaw. (No. 2666.) Pp. 3+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 1: Ants of the Genus *Amblyopone* Erichson. By William Morton Wheeler. Pp. 29. 75 cents. Vol. 62, No. 2: The Geology of Saint Helena Island. (Shaler Memorial Series.) By Reginald A. Daly. Pp. 31-92+25 plates. 3 dollars. (Boston, Mass.)

International Hydrographic Bureau. Special Publication, No. 19: Ocean Currents in relation to Oceanography, Marine Biology, Meteorology and Hydrography. By Rear-Admiral A. P. Niblack. Pp. 43. (Monaco.) 30 cents.

Bulletin of the National Research Council. Vol. 11, Part 3, No. 57: Molecular Spectra in Gases; Report of the Committee on Radiation in Gases. By Edwin C. Kemble, Raymond T. Birge, Walter F. Colby, F. Wheeler Loomis and Leigh Paige. Pp. 358. (Washington, D.C.: National Academy of Sciences.) 4 dollars.

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-verbaux des Réunions, Vol. 42: Investigations of the Production of Plankton in the Oslo Fjord. By Torbjørn Gaarder and H. H. Gran. Pp. 48. Journal du Conseil. Rédigé par E. S. Russell. Vol. 2, No. 1. Pp. 107. (Copenhague: Andr. Fred. Høst et fils.)

CATALOGUES.

Catalogue of Standard Literature, including Library Sets, Greek and Latin Classics, Modern and Private Press Books, First editions French Literature, etc. (No. 294.) Pp. 86. (London: Francis Edwards.)

Wild-Barheld Electric Furnaces. Pp. 8. (London: Automatic and Electric Furnaces, Ltd.)

A Complete List of Chapman and Hall's Scientific and Technical Books. Pp. 96. (London: Chapman and Hall, Ltd.)

Diary of Societies.

SATURDAY, APRIL 23.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 9.30 A.M., 11.30 A.M., and 2.15.—General Discussion on The Theory of Strong Electrolytes. Part II. Activity.—J. N. Bronsted: Introductory Paper. On the Activity of Electrolysis.—R. H. Fowler: Strong Electrolytes in Relation to Statistical Theory, in Particular the Phase Integrals of Gibbs.—D. L. Chapman: Note on the Theory of Debye and Huckel.—N. Bjerrum: Anomalies in the Theory of Solutions of Strong Electrolytes.—G. Scatchard: Mixed Solutions of Electrolytes and Non-electrolytes.—H. S. Harned: On the Thermodynamic Properties of a few Concentrated Salt Solutions.—F. Foxton and W. J. Shutt: The Activity of Zinc Chloride in Concentrated Solution.—C. A. Kraus: Influence of Salts on Solubility in Non-aqueous Solvents.—J. H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley: The Use of Amalgam Electrodes for determining Activities in Methyl Alcohol.—M. Randall: (a) The Significance of the Activity Coefficient; (b) Methods of Calculation of Activity Coefficient.—Prof. J. R. Partington: Electrochemical Properties of Non-aqueous Solution of Strong Electrolytes.—Prof. T. M. Lowry: The Definition and Characteristics of Strong Electrolytes.—H. Millet: The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at County Hall, Ipswich), at 10.45 A.M.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.—J. S. Carson: The Dry Cleaning of Coal.—The following papers will be open for further discussion:—The Chemical Relations of the Principal Varieties of Coal, Prof. G. Hickling; Screening and Washing Plant at Deaf Hill Colliery, L. F. H. Booth; The Economic Working of Thick Seams in New South Wales, W. Rawling.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow) — Annual Meeting.

MONDAY, APRIL 25.

ROYAL IRISH ACADEMY, at 4.15.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr. M. G. Kyle: Ancient Sodom in the Light of Modern Science.

INSTITUTE OF ACTUARIES, at 5.—J. G. Baker: Casualty Insurance in the United States of America.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—H. W. Cadman: Parcel and Package Conveying Plant.

RAILWAY CLUB (at 25 Tothill Street, S.W.1), at 7.30.—Debate, That the Grouping of British Railways has not been Beneficial.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. G. F. Goldsborough: Recent Discussions on Time.

ROYAL SOCIETY OF ARTS, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (1).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at 89 Wardour Street, W.1), at 8.—Prof. J. W. Hinchley: Permanent Moulding Machines for Cast Iron.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—E. C. Spraxson: Further Investigations of the Pathology of Dentigerous Cysts, with a New Treatment Based Thereon.

TUESDAY, APRIL 26.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of March 1927.—Sir A. Smith Woodward: Exhibition of Photographs of some Cretaceous Fishes from the Lebanon.—Dr. R. G. Cant: Exhibition of Cinematograph-films of Living-tissue Cultures showing Cell-division.—Dr. J. Beattie: The Visceral Lymphatic Channels of the Catarrhine.—R. I. Pocock: The External Characters of the Bush-Dog (*Speothos venaticus*) and of the Maned Wolf (*Canis jubatus*).—Edith Berkeley: A New Genus of Chaetopteridae from the N.E. Pacific: with some Remarks on allied Genera.—S. Hirst: Note on Acari, mainly belonging to the Genus *Spinturnix*, von Heyden.—Marjorie E. Shaw: On a Collection of Sponges from Maria Island, Tasmania.

INSTITUTION OF CIVIL ENGINEERS, at 6.—J. P. Porter: Bridge-foundations on Transported Chalk, with Notes on Piled and Monolith Foundations.

ILLUMINATING ENGINEERING SOCIETY (at National Physical Laboratory), at 7.—H. Buckley: The Work in the Photometry Department of the National Physical Laboratory.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at Junior Institution of Engineers), at 7.—Cinema Evening.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Dr. T. Slater Price and J. W. Glaslett: Thiocarbamide as an Impurity in Thiocyanates.—C. Lighton: A Contribution to the Theory and Practice of the Carbro Process.—J. O. C. Vick: Note on the Performance of the B.P.R.A. Photo-Electric Density Meter.

WEDNESDAY, APRIL 27.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield University) (Annual General Meeting), at 3.—General Discussion on Furnace Efficiency, introduced by A Brief Review of Furnace Developments, Prof. W. E. S. Turner.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—F. W. Shotton: The Conglomerates of the Enville Series of the Warwickshire Coalfield.—F. C. Phillips: The Serpentine of the Shetland Islands, and the Associated Rocks and Minerals.

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INSTITUTION OF CIVIL ENGINEERS, at 6.30.—Annual General Meeting of the Association of London Students.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Prof. E. W. Marchant: High-Frequency Currents (Kelvin Lecture).

ROYAL SOCIETY OF ARTS, at 8.—G. E. Key: Fire-Waste (Loss of Property by Fire) and its Effects on the Economy of National Life in Great Britain (Fothergill Prize Essay).

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND (London and South-Eastern Counties Section), at 8.—G. Stubbs: Some Recent Legislation affecting Chemists.

ROYAL SOCIETY OF MEDICAL SCIENCES (Surgical Section), at 8.30.—Annual Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section).

THURSDAY, APRIL 28.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. E. W. Hobson: On the Integration of Trigonometrical Series.—G. Polya: Note on Series of Positive Terms.—Prof. H. W. Turnbull: Self-conjugate Polygons for Quadrics and Linear Complexes.—D. R. Ward: Some Series Involving Euler's Function.

ROYAL METEOROLOGICAL SOCIETY, at 5.30.—Sir Samuel Hoare, Bart.: My Recent Flight to the East.

CHILD-STUDY SOCIETY (Annual Meeting), at 5.30.—At 6.—Dr. J. N. Glaister and Miss Josephine Richardson: Discussion on Problems in the Up-bringing of Children.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Major R. E. Penny: Seaplane Development.

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY, at 7.

INSTITUTE OF METALS (London Local Section) (Annual General Meeting) (at 88 Pall Mall, S.W.), at 7.30.—E. I. Thorne and others: Discussion on The Working of Metals.

INSTITUTION OF STRUCTURAL ENGINEERS (at 10 Upper Belgrave Street, S.W.1) — Debate, That the System of Education of Structural Engineers by Articled Pupillage is Contrary to the Best Interests of the Student, and should be Superseded by Education in Recognised Engineering Schools.

INSTITUTE OF CHEMISTRY (London Section).

FRIDAY, APRIL 29.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (at Victoria Hospital for Children, Tite Street, S.W.8), at 4.—Clinical Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. F. C. Lea and F. Heywood: The Failure of Some Steel Wires Under Repeated Torsional Stresses at Various Mean Stresses.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—C. Le Maistre: Simplification and Standardisation of Details in Ships and their Machinery.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at University College, Dundee), at 7.30.—D. S. Munro: Modern Electrical Wiring, particularly as applied to Small Houses.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 7.30.—L. H. Evans: The Stress-strain Diagram and its Application to the Testing of Rolling Stock Draw Gear.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. F. Cooper: The Design and Balancing of Three-phase Low-tension Distribution Systems.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Sir William Hamer: The Influenza Constitution.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. V. Appleton: Wireless Transmission and the Upper Atmosphere.

DIESEL ENGINE USERS' ASSOCIATION (at Cavton Hall, Westminster) — O. Wans: Further Developments in Mechanical Injection Oil Engines.

SATURDAY, APRIL 30.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Rider: Feeding and Treatment of Animals below Ground and Stabling.

PUBLIC LECTURES.

THURSDAY, APRIL 28.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Sir Almoth E. Wright: On the Treatment of Bacterial Infections by Antibodies and Chemical Agents.

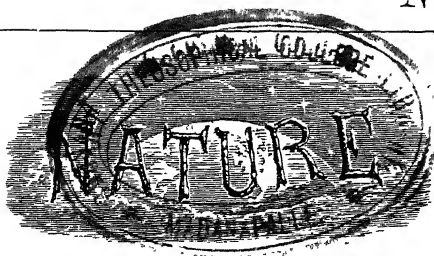
FRIDAY, APRIL 29.

SCHOOL OF ORIENTAL STUDIES, at 5.30.—Prof. J. P. Vogel: The Development of Ornament in Indian Art. (Succeeding Lectures on May 3 and 5).

CONFERENCE.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haensch and Lorey, and Fleischner.



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Minerals and Metals of the British Empire.

THE War brought into painful prominence certain facts regarding the resources and distribution of commodities, animal, vegetable, and mineral, which had indeed long been known, but the real significance of which in such a period of stress had not been fully grasped by any one of the Powers concerned. The waste of time, man-power, and material involved in the efforts made to overcome the resulting difficulties created a profound impression, from which flowed a stream of resolutions and good intentions. Meanwhile the years are slipping by and there is yet little indication of an Empire policy regarding minerals and metals.

While it is obvious that the development and conservation of the resources of the British Empire in plant and animal life require all the care and attention that can be given them, the case of minerals is peculiar. It is generally admitted that there is, in accessible form, enough of every mineral in the world to enable its inhabitants to carry on along present lines for a great period of time; but the distribution is unequal, the demand for certain minerals may at any moment overstep the known resources, new sources have to be discovered, and when they have been found and exploited they cannot be rejuvenated or replaced.

One of the lessons of the War was the need for each nation to be fully aware, in detail, of its own resources in minerals and of the means available for rendering them fit for industrial purposes and munitions of war; to be aware also of its actual relations with the rest of the world with respect to resources, transport, marketing, and treatment of minerals. The official statistics available to Governments are practically limited to those of production and of movements, represented by imports and exports. Such statistics, though better than none and essential for certain purposes, convey a totally erroneous conception of the actual resources of a territory; they throw no light on those available for future exploitation; they are always too late to indicate the significance of new finds; and they contain no reminder of the reserves that are fairly accurately known but are not exploited under the fiscal or commercial conditions that are prevalent at the time of their publication. For many years the United States, through its Geological Survey, and later, the Bureau of Mines, has done good service, not solely to its own nationals, by the publication of elaborate statistics relating to the mineral resources of the

States, with such figures as could be assembled regarding other countries, and frequently enlivened by informative reviews of the industry in specific minerals. It was not unnatural, therefore, on ground so well prepared, that Spurr's "Political and Commercial Geology," in 1920, should have stimulated the two leading institutions of American miners and metallurgists to form a joint committee under the chairmanship of Prof. C. K. Leith, to consider and report upon foreign and domestic mining policy and industrial preparedness ("International Control of Minerals." New York, 1925).

This Committee enunciated certain propositions "in the interest of efficient and conservation use of the world's mineral resources and in minimising international difficulties arising from the discovery, development, transportation, and marketing of mineral resources." The propositions put forward cannot be discussed here; in the main, they are equally applicable to any great State. In other quarters there is evident the same desire that these problems should be attacked; quite recently, from Germany, comes a proposal for the formation of an "International Institute of Mines." As things are at present, however, it is more practicable to restrict the field of action to States or federations of States.

The matter has recently been taken up with vigour by Sir Thomas Holland: in a presidential address in 1925 (*Trans. Inst. Min. and Met.*, 34, 1925, pp. xlv-lxiii), he directed attention to the possibility of shortages of certain base metals in the not very distant future; in 1926, at the Royal Society of Arts ("International Interests in Raw Materials," *Jour. Roy. Soc. Arts*, 75, 1926, pp. 42-61), he enlarged upon the need for investigation and collection of data regarding the natural resources of the British Empire; this has been followed up by his paper, a "Proposed Review of the Mineral Resources of the Empire," read before the Institution of Mining and Metallurgy on April 21, part of which is printed elsewhere in this issue.

In this paper Sir Thomas proposes that: "In each of the Dominions and, if possible, in each of the larger Colonies, committees of specialists should be appointed and entrusted with the duty of reviewing for each large State or unit of area its mineral resources and smelting capabilities, having in mind the desirability of accumulating, in addition to the ordinary official statistics of production and movement, the essential data necessary for the formulation of an economic policy, as well as for obtaining the information required to institute measures designed to secure military safety."

These proposals are now under discussion in London, and, if approved, it is intended to submit them, with such modifications as may be deemed desirable, for further discussion by the second Empire Congress of Mining and Metallurgy to be held in Canada this autumn. Should the Congress adopt the scheme and proceed to put it into being, there will be for the first time within the British Empire an organisation for the collection of live data and for the prompt examination and elucidation of their implications by men with knowledge of the facts.

The essence of the plan is decentralisation: in each territorial unit, whatever it may be, the special committee would be responsible for the collection and consideration of data within its ambit, and its methods would be those best suited to the local circumstances and special problems. The co-ordinating bodies would be the constituent members of the Empire Council of Mining and Metallurgical Institutions, established at the first Congress, held at Wembley in 1924, in order that each may benefit by the experience of the others, and especially in order that correlation and subsequent economic co-operation by the various Governments may be facilitated at future Imperial conferences of the kind recently held in London.

It is suggested that reports of progress made by the special committees in the Dominions during the next three years should be discussed at the Empire Mining and Metallurgical Congress, which will be arranged to follow that to be held at Montreal this year. The International Geological Congress has shown that it is possible, even with a very loose organisation, to assemble information of a most valuable character on specific subjects, exemplified in the reports on the world resources of coal and iron. The scheme to be laid before the Empire Congress in Canada is more far-reaching: it involves the consideration not only of the mineral resources and their development and treatment in the units of the British Empire, but also of the changing interactions, as adjustments take place due to new discoveries, new methods, new migrations of material, the growth of new industrial centres, and the consequences of political action. In short, to fulfil its functions properly, the proposed organisation must be not only alive but also assured of a prolonged life.

The territorial committees will have to concern themselves with such questions as the conservation of minerals; the encouragement of prospecting; the support of the geological survey, keeping it in touch with realities and advising on the choice of

areas ripe for intensive geological investigation ; the elimination of wasteful methods of mining, and of movement of ore ; and the consideration of suitable centres for refining and smelting. The local mining laws should be critically examined with the view of simplification and, so far as possible, unification. Statistics should be analysed and presented in more useful form.

The discussion of these and other matters would be carried on by the Congress and Empire Council from the point of view of Empire requirements. Amongst the larger questions might appear that of State ownership of minerals, the inclusion of mining in the public utility services, the accumulation of reserve stocks, fiscal interrelations, etc., which cannot be dealt with by the official and State-aided organisations already existing for the collection and publication of mineral statistics.

While such an organisation as the Imperial Mineral Resources Bureau will doubtless continue to function usefully, the scheme outlined by Sir Thomas Holland would be far more effective in securing the essential details promptly and their consideration by specialists actually in touch with the ramifications of the industry. It is only by some such process that the great industries of mining and metallurgy can be brought into a position from which they can speak with full authority to their several Governments, and thus influence the creation of sound domestic and Empire politics.

An Engineer-Astronomer.

The Scientific Papers of William Parsons, Third Earl of Rosse, 1800-1867. Collected and republished by the Hon. Sir Charles Parsons, K.C.B., F.R.S. Pp. v+221+18 plates. (Newcastle-upon-Tyne: Sir Howard Grubb, Parsons and Co., 1926.)

IT is always interesting and sometimes profitable to turn for a moment from the achievements of to-day to contemplate the difficulties, struggles, and aspirations of the pioneer in some special field of scientific endeavour. To do so, however, is not always a simple matter, since it often entails a laborious search through the publications of various learned societies ; and, at the end of the search, a feeling that something of importance may after all have been missed. When, however, the whole of the written work of some specialist has been collected together and republished in one volume, it can be studied at any time with the greatest facility.

All those who are interested in the history and development of the reflecting telescope have cause

for satisfaction in that this collation of scientific work has been effected in recent years in the case of two of the most distinguished pioneers in the construction and improvement of that instrument.

In 1912 the collected scientific papers of Sir William Herschel were published by the Royal and Royal Astronomical Societies. Among these papers is one which gives a fairly full account of the construction and working of that great 40-foot reflector which may justly be described as the world's first giant telescope, destined not to be doubled in aperture for 130 years. It is only to be regretted that Herschel published very few details of the purely optical part of his work. Fortunately, however, he did commit to writing a very full account of his methods of figuring specula ; and, as this manuscript is still extant, it is to be hoped that it may yet one day be published.

We have now before us the scientific papers of William Parsons, third Earl of Rosse, brought together and published in one volume by his son, the Hon. Sir Charles Parsons. These papers, considered in relation to the work of Herschel, may be said to constitute the next chapter in the history of the reflecting telescope. Unlike Herschel, Lord Rosse had no special reason for reticence with regard to his methods, and the full account which he gives of his many optical experiments, successful and unsuccessful alike, makes very interesting reading. Thus, the first paper of the series, written in the days before he had fully mastered the art of figuring his specula to a paraboloid, describes a simple and ingenious method of reducing the aberrations of a spherical surface. This he accomplished by casting a speculum in two concentric parts, with a small space between them. The two parts were then worked together to what was, optically, a single spherical surface. The resulting spherical aberration was then reduced by drawing back the central portion by means of three fine screws. It is rather surprising to read that this apparently crude method proved successful in a mirror having a focal ratio of only 1 to 4 ; but, as the aperture of this speculum was only 6 in., it seems unlikely that it was called upon to bear very high powers. Yet its maker was so satisfied with it that he declared his intention of constructing one (in three pieces) so large as 18 in. in diameter. But no such instrument is afterwards mentioned, and it appears that Lord Rosse soon turned instead to more promising methods of improving, and more particularly enlarging, his specula.

In this connexion many of Lord Rosse's experi-

ments were directed towards increasing the rigidity of metallic mirrors, and at the same time reducing their weight. To this end he tried the expedient of casting some specula of moderate size with backs braced by straight ribs, and some others with backs of a cellular structure. The results were not altogether successful, and it is interesting to note that similar experiments made on glass mirrors in recent years have also failed to justify expectations.

Most noteworthy, however, of all Lord Rosse's experiments are of course those connected with the casting and figuring of really large specula. The primary difficulty was the successful annealing of large masses of speculum metal in which the copper content was relatively low; for only to such mirrors was it possible to impart a really brilliant and lasting polish. While this difficulty was still outstanding, Lord Rosse turned for a time to an alternative expedient—that of building up a speculum of a number of thin plates of a highly reflective but brittle composition. These plates were soldered side by side to a stout backing of brass, so compounded as to have as nearly as possible the same coefficient of expansion. Except for diffraction effects, caused by the intervals between the plates, this built-up speculum, of 3 ft. diameter, seems to have been entirely successful.

Meanwhile a solution to the annealing problem had been found. It consisted in the casting of specula on a bed of hoop-iron packed tightly on edge. This promoted the rapid and regular cooling of the metal from below upwards, and by its means Lord Rosse was able successfully to cast specula of 6 ft. diameter. Two of these were eventually cast for use in the great reflector which marked the crowning point of the efforts of this tireless experimenter. The actual figuring of these great masses of metal, weighing three or four tons apiece, seems, strangely enough, to have presented comparatively little difficulty. It was of course necessary to devise special grinding and polishing machinery, all of which is fully described and illustrated in the papers; but previous experience with smaller specula had apparently done much to smooth the way for this greater undertaking. Much more serious was the difficulty of so mounting the finished mirror as to free it from the risk of flexure. However, this difficulty was almost completely met by mounting the speculum on a series of triangles, supported by levers, after the plan devised by Thomas Grubb. The design and erection of a mounting for the great telescope gave plenty of scope to the engineering ability of its constructor;

and it is here worth remarking that the entire instrument was from first to last the product of local labour, under the instruction of Lord Rosse himself, and that the total cost was only £8000.

The actual work done with the great telescope, especially in revealing for the first time the spiral structure of certain nebulae, is a matter of astronomical history, and need not here be described. One point, however, brought out clearly in the detailed description of the telescope's performance, seems worthy of emphasis in view of statements sometimes to be found in less authoritative accounts. We refer to the defining power of the great speculum, which has often been described as being of a distinctly inferior order. That there were many occasions when, in the climate of Ireland, such a telescope would perform but poorly, will be readily understood by all who have worked with large apertures; also it appears that flexure was occasionally a source of trouble; but, on the other hand, it is equally clear, from details given here and there in the papers, that the telescope did at times perform splendidly, even under high powers, which it certainly could not have done had the figure of the speculum been appreciably defective.

The volume closes with some interesting extracts from the correspondence of Lord Rosse bearing on the early history of the 'ironclad.' Apart from any value they may have had at the time they were written, they serve to illustrate the versatility of this remarkable man; and it seems worth remarking that they were destined to be by no means the last contributions of the Parsons family to the science of marine engineering.

W. H. S.

Specialised Plant Tissues.

- (1) *Handbuch der Pflanzenanatomie*. Herausgegeben von Prof. K. Linsbauer. Abteilung 1, Teil 2: *Histologie*. Band 4: *Meristeme*. Von Dr. Otto Schüepp. Pp. vi + 115. 8-70 gold marks.
- (2) Band 5: *Die Bewegungsgewebe*. Von Prof. Dr. Hermann von Guttenberg. 25-50 gold marks. (Berlin: Gebrüder Borntraeger, 1926.)
- (3) *Das Archiplasma: Betrachtungen über die Organisation des Pflanzenkörpers*. Von Prof. Dr. Hugo Miehke. Pp. vi + 92. (Jena: Gustav Fischer, 1926.) 4 gold marks.

(1) **D**R. SCHÜEPP'S own contributions to our understanding of the part played by the plant meristem are a guarantee that this section of the new handbook of plant anatomy is in safe hands. He points out that after a period, from 1870 until

1880, when the meristem, and especially the growing point, was the centre of botanical interest, the subject has somewhat fallen into the background, to be brought forward again to-day, to some extent, in the attempt to understand some of the phenomena of graft hybridisation and especially periclinal chimæras. It is interesting, therefore, to see how concepts that were formulated in an earlier period of botanical activity fare when made the basis of treatment in a modern monograph of the subject.

Dr. Schüëpp presents the subject as a problem requiring elucidation from the viewpoint of causal anatomy, but he is not inclined to attach great significance to attempts to explain cell division, its order and direction, along the lines of simple physical laws, as foreshadowed to some extent by Berthold in his "Stüdien über Protoplasma-mechanik." He discusses the different types of apical meristem of the vascular cryptogam and the flowering plant, finding a transition between the apical cell of the former and the uniform meristematic tissue of the latter in the initial cells of the apex of the axis of the Lycopodiales and Gymnosperms. The initial cell is not an apical cell, because it is not characterised by special size, form, or manner of division, but it is a cell or group of cells from which all the tissues of the growing region derive. In the Gymnosperms, Haustein's distinctions of dermatogen, periblem, and plerome cannot hold, even the dermatogen showing occasional periclinal divisions, and the result of the discussion is evidently to minimise their importance in the complex construction of the Angiosperm apex. For the root another distinction of 'cap' and 'core' is drawn, the cell series in these two regions arising from the 'urmeristem' by a different order of cell division, which affects their symmetry as derivatives of the active apical meristem. Root systems are then classified according to the relative share these two tissues play in the differentiated root; the cap may only form the root cap—on the other hand, it may form every tissue from the outside of the root cap down to the endodermis.

Embryonic meristems are also briefly discussed, Sonèges being chiefly followed here, but the monograph is mainly valuable for its clear and critical discussion of the activity of the apical meristems of shoot and root. It is interesting to see that the theory that the endodermis acts as a tissue-absorbing pocket, in advance of the growing point of the secondary root, is given on the authority of the earlier workers without comment,

though it has been thoroughly negated by Friedrich Lenz (in 1910-11) and is not supported by any modern experimental work so far as is known to the reviewer.

(2) Prof. Guttenberg has made a very full compilation of the literature in a somewhat artificially delimited field of plant anatomy. Naturally the treatment is of adult tissues, without consideration of development, and from a strictly teleological viewpoint. The classification adopted in the same field by Haberlandt is followed without alteration.

Tissues involved in active movements such as dehiscence or growth mechanisms, etc., are first distinguished from tissues concerned in passive movements, such as the floating mechanisms of water-dispersed seeds and fruits. Tissues concerned in active movements are classified as dead or living tissue systems. In the dead systems those depending upon hygroscopic movements in anisotropic wall systems are distinguished from mechanisms such as the fern annulus, which depend upon the cohesive pull upon elastic walls, exerted by the gradual diminution of the water content in cells full of water. There is a very brief discussion of growth curvatures, as these are not usually associated with special tissue systems. A brief description of stomatal movement is found amongst living tissue systems associated with movement; this discussion is restricted to the effect of the histology of the guard cells and other special cells upon the movement mechanism. A very complete bibliography is included.

(3) In this monograph Prof. Miehé passes in review many of the puzzling facts associated with the capacity for reproduction, especially vegetative propagation, of the plant. He then suggests that the capacity of a cell to construct new protoplasm and then multiply by division, in other words, the meristematic properties of the cell, may be a function of its content in a special type of protoplasm, the 'archiplasm.' Cells of the permanent tissue, incapable of reproduction, are then deficient in this 'archiplasm.' Prof. Miehé terms them 'ergoblasts' as compared with the potentially reproductive 'archiplasts,' which in the meristem of a growing point may be massed in an 'archenchyma.' This new viewpoint evidently admits of a re-interpretation of well-known phenomena in terms of a new phraseology, but as the 'archiplasma' cannot be recognised save by its effects on reproduction, and as no new experimental method of attack is suggested, it is questionable if it does much more. It at least puts upon record

Prof. Miehé's view that all living cells of the plant cannot be regarded as 'totipotent' in reproduction, a viewpoint towards which Vochting's experiments had led him.

This theoretical conception of the 'archiplasm' is applied in a very brief general review of reproduction and regeneration in the plant. The subject is one on which generalised statements are difficult to make, and two are noted to which exception can certainly be taken, namely, the statements (p. 37) that adventitious roots arising upon shoots always appear in the pericycle, and (p. 39) that the phellogen is a tissue which is never associated with the origin of buds.

Synoptic Psychology.

Mind and Personality: an Essay in Psychology and Philosophy. By Dr. William Brown. Pp. x+344. (London: University of London Press, Ltd., 1926.) 12s. 6d. net.

ALL those who are well acquainted with recent psychological thought must turn with unusual interest to a comprehensive expression of the views of Dr. William Brown. This they will find set forth in the volume now offered to us, which—to use the author's own words—is "an attempt to obtain a synoptic view of personality, as considered from the standpoints of the various sciences—especially from those of psychology, psycho-pathology, and philosophy."

Besides these three sciences, however, there might well have also been made a claim for physiology. For from this latter it is that Dr. Brown first embarks upon his course, and in a definitely anti-mechanistic direction. "Although the body," he says, "does obey physical and chemical laws, processes nevertheless go on in it which are inexplicable in those terms." Among the non-mechanical characteristics of bodily conduct he enumerates "spontaneity," "persistence of action after the stimulus producing the action has disappeared," "the coming to an end of the activity after a certain purpose has been achieved," "the power of learning by experience," the action of "the organism as a whole"; in short, the fundamental fact that "all animal behaviour is purposive."

Turning to the point of view of psychology, we find that the author rather curiously trisects this into "psychology" pure and simple, "experimental psychology," and "child psychology." Dominating the first of these three divisions comes for him the conception of the mind "as a system

of interests, with emotional reactions, showing different degrees of unity in the systems of subordinate unities; these systems being incorporated in wider systems, and these wider systems again being incorporated in still wider systems, till at last one has a total system dominated by one all-satisfying interest." As for "volition," this he takes to consist of "the whole character in action with the sentiment of self-respect in command." In his second or "experimental" division of psychology we come upon an assortment of such topics as psycho-physical methods, cutaneous sensibility, visual experience, mental variation, and mathematical ability. His third and last division, that which deals with the child, is most notable for warning that undesirable juvenile propensities should be counteracted, not by "repression," but instead either by "substitution" or else by "sublimation."

From the author's next scientific point of view, that of psycho-pathology, he strongly defends the distinction that has been drawn between "organic" and "functional" nervous disorders. As regards the latter, he urges that "physical and physiological methods of treatment have shown themselves thoroughly inadequate to cope with the situation." In their place he recommends, not so much "psycho-analysis" in particular, as rather "deep analysis" in general. This supplies a procedure whereby to resolve the abnormal systems of interests called "complexes," as also possibly the normal systems called "sentiments." Here—and indeed almost throughout—he is greatly influenced by the teachings of Freud, which he either admiringly accepts or else sharply contests. An example of the critical attitude is his emphatic rejection of the belief that a young child has ever present a strong feeling of hostility towards the parent of like sex. He further repudiates the suggestion that the unity of the mind has been proved to be a comparatively late mental product. On the contrary, he says, "the results of psychological analysis itself show an underlying thoroughgoing unity."

The author's third or philosophic point of view brings him to the topic of ethics; and here he ranges himself on the side of the intuitionist school. Turning, next, to the theory of evolution, he proceeds to combat the "aimless freedom of spontaneous activity and pure duration" advocated by Bergson, and would substitute in its place the "real freedom of deliberate choice." Then follows his treatment of the problem which appears to have for him the deepest interest of all; it is that

of religion, which he defines as an attitude "of personal relationship towards the universe." This leads him, finally, to the region of mysticism, where his counsel is that we should seek to transcend time and in such wise follow the exhortation of Aristotle "to be immortal as far as possible even in this life."

On the whole, Dr. Brown ranges over an extraordinarily wide field. But for so doing he can at least claim the high sanction: *Wer vieles bringt, wird manchem etwas bringen.*

C. SPEARMAN.

A New Approach to Zoology.

The Elements of General Zoology: a Guide to the Study of Animal Biology, correlating Function and Structure; with Notes on Practical Exercises.

By Prof. William J. Dakin. Pp. xvi + 496. (London: Oxford University Press, 1927.) 12s. 6d. net.

ZOOLOGY has been suffering during recent years under the unjust and wholly undeserved criticism that it does not readily lend itself to experiment and is therefore, in this respect, inferior to botany as a subject for inclusion in the school curriculum. It is true that there is still a tendency to lay too much stress on structures and to neglect the functions served by those structures, but this is the fault of the teachers rather than the subject. Prof. Dakin's book is at once a complete justification of the right of zoology to be considered as an experimental subject for school work, and a guide to the teacher as to how the relative claims of function and structure can be adequately met in their courses. Function is the dominating note of the book and, except for a chapter specially devoted to the Protozoa, the subject matter is arranged under the headings of the various functions of animals and not under the customary systematic groups. In dealing with any one function, the author has given just so much structural detail of the organs concerned as is necessary for a proper comprehension of their uses, and has saved much valuable space by the free use of carefully annotated drawings and diagrams to impart the details of anatomy.

Among the most valuable parts of the book are the experiments, which are carefully outlined in each chapter, for practical demonstration of the physiological processes underlying function. The material chosen for these experiments is readily obtainable and easy to manipulate; the experiments themselves are simple and the apparatus

inexpensive. With these as their guide, teachers should have little difficulty in making intelligible, even to their younger pupils, the life processes of the living animal. They will at least be able to make zoology a living science.

The book is intended mainly as a guide to the study of animals through their functions, but in order to meet the needs of laboratories where one type is studied at a time in the practical classes (and this must inevitably be the case in most school laboratories), the author has assembled in the index all references to a particular type under one heading, so that the book readily lends itself for use as a practical text-book from the systematic point of view. Special praise must be accorded to the illustrations. Not only are they clearly and beautifully reproduced, but also they have been chosen with great care, and in nearly all cases have been modified and specially annotated. Their value has been enhanced enormously thereby.

Prof. Dakin has, in our opinion, abundantly justified the preparation and publication of this book. It strikes a new note in text-books of zoology, and should prove of incalculable help to teachers of biology in schools, while university teachers will find much in it of real use for their intermediate courses. It is the most refreshing and stimulating text-book, from the teachers' point of view, that has been published for some time. The Oxford Press deserves special commendation, not only for the admirable way in which the book has been produced, but also for its remarkably low price.

Our Bookshelf.

Ancient Cities and Modern Tribes: Exploration and Adventure in Maya Lands. By Thomas Gann. Pp. 256 + 32 plates. (London: Gerald Duckworth and Co., Ltd., 1926.) 21s. net.

FOR several years past, Dr. Gann has published annually a volume containing an account of his adventures and experiences while engaged in archaeological exploration in Central America during the preceding winter. Entertaining and instructive as the preceding narratives have been, the present surpasses them in interest, as it contains not only an account of the further exploration of the remarkable site of Lubaantun, opened up in the preceding year, but it also records one of the most sensational discoveries hitherto made in American chronology, as well as the revelation of an entirely new and unexpected centre of Mayan culture, of which many features are unique.

Any one of these achievements would have served to assure the success of the expedition from the scientific point of view, and would have afforded ample compensation for the hardships it entailed.

The dated stela found at Chetumal Bay shows an Initial Series which, on Spender's correlation, corresponds to Oct. 26, A.D. 333. This is the earliest of the four series found in Yucatan by nearly three centuries, and shows that the Maya had obtained a foothold in this part of the country long before it was supposed to be inhabited at all. Dr. Gann, after visiting the "Cave of Flowers," which he suggests with reason may yield to exploration vestiges of early man, went on to Coba, attracted thither by a suggestion in a recent translation of an ancient Maya manuscript. The gigantic causeway leading to the site must be, in its way, one of the most remarkable achievements of Maya mechanical skill, while the temple mound at Coba itself is probably the highest in Yucatan. The special interest of the site, apart from the many peculiar characters of its three types of Maya civilisation, lies in the fact that it does not appear to have come under Toltec domination—a fact which will undoubtedly prove of no little importance when the exact bearing of Dr. Gann's discoveries on Maya history has been worked out.

It has not been possible even to touch upon the many matters of the greatest archaeological interest to which Dr. Gann himself has sometimes only been able to refer in passing, and a more extended and detailed report will be eagerly awaited. It must not be thought, however, that Dr. Gann has confined himself to matters archaeological. His account of the incidents of his journey and of the people he met are, as usual, both informative and amusing.

Zoologisches Wörterbuch: Erklärung der zoologischen Fachausdrücke; zum Gebrauch beim Studium zoologischer, anatomischer, entwicklungsgeschichtlicher und naturphilosophischer Werke. Verfasst von Prof. Dr. E. Bresslau und Prof. Dr. H. E. Ziegler. Unter Mitwirkung von Prof. J. Eichler, Prof. Dr. E. Fraas, Prof. Dr. K. Lampert, Prof. Dr. Heinrich Schmidt, und Prof. Dr. J. Wilhelm. Revidiert und herausgegeben von Prof. Dr. H. E. Ziegler und Prof. Dr. E. Bresslau. Dritte vermehrte und verbesserte Auflage. Pp. viii + 786. (Jena: Gustav Fischer, 1927.) 28 gold marks.

THE proof of the first half of this new edition was corrected when the sudden death of the senior author, Prof. H. E. Ziegler, occurred on June 1, 1925. Prof. Bresslau has therefore been responsible for the revision of the second half of the volume. The aim of the book is to give a definition or brief explanation of the terms used in zoology, of the classes and orders of animals, of the most important families, and of those genera which are of special significance from a theoretical or from an economic point of view. The classical origins of the terms and of the generic names are given, and in many cases the author of a term is cited, e.g. "Gastrula (Haeckel, 1872)."

The authors must have been often faced with the difficulty as to what to include and what to omit, and individual readers will no doubt wish that more could have been included. For example,

Gyrodactylus and mitochondria receive notice, but Gyrocotyle, Stegomyia, and the Golgi apparatus are omitted. Errors appear to be remarkably few; Bilharzia is said to occur in the kidney, the fleas are stated to form a single family (modern practice is to divide them into two families), and Geotria is referred to as a South American genus, whereas three of its four known species are Australasian.

The cross references are in several cases out-of-date, e.g. under Ancylostomum (the official spelling is Ancylostoma) the reader is referred to Doehmius, and under Giardia to Cercomonas, but Ancylostoma and Giardia are the names now in use, and the description should be under these heads and not under the obsolete names. The illustrations (575 in number) are on the whole good, but a few are unsatisfactory, e.g. *Balantidium coli*, *Pulex irritans*, malaria and Sarcocystis (especially the spores). But these are small blemishes in a work so large and so difficult to prepare. The volume may be recommended as a helpful and trustworthy work of reference.

Electrical Contracting: a Guide and Handbook specially designed to meet the Needs of all those engaged in Business as Electrical Contractors. By H. Ayres Purdie. Pp. xxxii + 375. (London: Ernest Benn, Ltd., 1926.) 10s. 6d. net.

ELECTRICAL contractors form a very important section of the engineering industry. It is curious, therefore, that so few books are published to meet their needs. It is necessary that they should know the best method of organising their businesses, preparing estimates, reading and supplying specifications, and preparing schemes for lighting, heating, and power. They have also to know the best materials to use in given cases.

We think that this book under notice will be found of practical use to contractors. In an introduction, stress is laid on the importance of good workmanship. To have cheap materials properly installed by a conscientiously competent workman is much preferable to having good materials casually and carelessly installed. Screwed steel conduit, for example, even when of the best quality, does not signify a safe installation if improperly fitted up. Special care has to be taken when choosing switches for bathrooms, kitchens, cellars, and so on. It is specially important also that the 'earthing' of the conduit be efficiently done. Useful information is given on illumination work, the number of foot candles required for all kinds of lighting being specified. The methods of installing electrical signs are described. We are told that the well-known 'neon' illumination of the Coliseum, Charing Cross, London, and the enormous *Daily Mail* sign at Blackfriars Bridge over the Thames, consume only 22 and 15 units per hour respectively. The high-tension side of these signs, which operates at pressures not less than 2000 volts and is consequently dangerous, is erected by the makers themselves. It is pointed out that it is sometimes advantageous to work the electric bells in a house from the alternating current supply.

The Steam-Engine and other Heat-Engines. By Sir J. Alfred Ewing. Fourth edition, revised and enlarged. Pp. viii+662. (Cambridge: At the University Press, 1926.) 25s. net.

THIS well-known work, which on its first appearance in 1894 set up a new standard of excellence in the writing of text-books on this subject, now appears as a fourth edition extensively revised and enlarged. In its pages students can gain a very good idea of the history of the development of heat-engines, while the basic thermodynamic theory is expressed with a notable clarity, simplicity, and scientific accuracy.

In new editions of standard text-books the additions are always of especial interest, and we now find here an enlarged section on the theory and practice relating to steam turbines, which in about a hundred pages gives an admirable survey of the subject. It is perhaps not possible now to give so connected an account of the internal combustion engine, which has become a serious rival to the steam turbine for the propulsion of ships. The battle is still being waged, but whatever may be the issue, applied science gains by the researches of Callendar and others on the properties of steam at great pressures and high superheats, and by the various investigations on the properties of the explosive charge in the cylinders of internal combustion engines, described in this volume. Many other subjects, arising from the great sizes of the engines now being designed and built, are dealt with; much research on these subjects has been carried out, and is still proceeding, in order to provide successfully for motive power in units of unprecedented size.

Students will be especially grateful for a text-book which covers so wide a range and brings them up to the boundary of existing knowledge.

E. G. C.

Floræ Siamensis Enumeratio: a List of the Plants known from Siam, with Records of their Occurrence. By Prof. W. G. Craib. (Published under the Auspices of the Siam Society.) Vol. 1, Parts 1 and 2: *Ranunculaceæ* to *Anacardiaceæ*. Pp. 1-197 and 198-358. (Bangkok: Bangkok Times Press, Ltd.; London: Luzac and Co., 1925 and 1926.) 7 Tcs.; 12s. 10d. each.

A USEFUL compilation, of which the first two parts have appeared, is in course of publication. It is a catalogue of all plants collected in Siam, with a full record of collectors' specimens, references to literature and synonymy, together with occasional notes by the author, who has critically examined, wherever possible, the type specimens and other specimens quoted. The local Siamese and Malay names are given. No new species are recorded, though very many of those listed have been described by the author himself in the *Kew Bulletin* from material supplied by recent collectors, chiefly Dr. A. F. G. Kerr, Mrs. D. J. Collins, and members of the Siam Forest Service.

The geographical situation of Siam lends special importance to its flora, for it is a focus for intrusive plants from south-west China, Burma, and the

Malay Peninsula. Possibly also (with the adjacent countries which go to make up Indo-China) it has been a centre from which certain species have been disseminated. It must, therefore, have a considerable bearing on the floristic relationship of those different regions.

C. FISCHER.

Crime and Custom in Savage Society. By Dr. Bronislaw Malinowski. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xii+132+6 plates. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1926.) 5s. net.

PART of this stimulating essay on primitive jurisprudence was delivered by Dr. Malinowski as a lecture at the Royal Institution and published in extended form in our columns (*NATURE*, Feb. 6, 1926, Supplement, p. 9). It is scarcely necessary, therefore, to do more than direct attention to its publication in book form, and to say that in the added matter the author has amplified his main contention that much of the general theory of the older school of anthropology fails to stand the test to which it can be submitted by the field-worker. In the present instance, in the field of primitive jurisprudence, Dr. Malinowski, with his acutely critical power of analysis, is able to show from his experience among the Trobrianders that the idea of group dominance is inadequate as a sanction of law and order in primitive society.

The Garden Interests of Madeira. By Dr. M. C. Grabham. Pp. xii+100+3 plates. (London: Printed by William Clowes and Sons, Ltd., 1926.) 5s.

DR. GRABHAM has written an interesting and useful little book on the plants found in gardens and growing wild in Madeira, which should be of value to visitors to this favoured island. In the second part the plants are discussed under their respective families and useful notes are given about them. The first part contains a good deal of miscellaneous information about the plants and their times of flowering, the various fruits and vegetables to be met with at different seasons, and other matters of interest to the visitor. This part fittingly contains at the end a portrait of the venerable and versatile author bearing the legend, "Archangelicus madeirensis!"

The Way of the Wild. By H. R. Sass. Pp. vii+321. (London: T. Fisher Unwin, Ltd., 1926.) 7s. 6d. net.

A SERIES of ten animal stories dealing with the adventures of a wide range of North American creatures, from owls and eagles to racoons, pumas, and bison. The stories are linked with the experiences of white hunters and Indians; they are well written, full of interest and excitement, and the author has avoided the danger of swamping the soundness of his natural history by a too vivid imagination. The value of the book lies in the likelihood that it may arouse in many who are not naturalists an appreciation of and sympathy with the lives of wild creatures, and naturalist and non-naturalist will enjoy the stories.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

X-ray Investigation of the Polymorphism of Fatty Acids.

DURING recent years X-ray analysis has been successfully applied to the investigation of long-chain organic compounds. The method seems especially adapted to the study of polymorphism of such substances (Piper, Malkin, and Austin, *Jour. Chem. Soc.*, 1926; 2310. G. M. de Boer, *NATURE*, Jan. 8, 1927. J. Thibaud, *C.R.*, 184, 24, 96; 1927).

The easiest method to follow is to make a thin film of the substance on a glass strip (by melting or by crystallising from a solution) and to use this as a 'turning crystal' in the X-ray spectrograph. By exposing the film to monochromatic X-rays, rather sharp lines are obtained, which are due to a long spacing present in the micro-crystalline film. This long spacing is a beautiful characteristic of the modifications of the substance which sometimes gives information not so well afforded by an investigation of other physical constants as the heat of transformation.

In continuation of such former work, I have studied in this manner the influence of temperature on the modifications of the odd and even saturated fatty acids. For this purpose the preparation was placed inside a small thermostat, which was mounted on the crystal table of the spectrograph. For the passage of the X-rays the thermostat was fitted with two windows covered with goldbeater skin. By electric heating it was possible to obtain temperatures from room temperature up to 60°, the temperature being measured with a mercury thermometer.

Using copper $K\alpha$ radiation, photographs were taken at different temperatures showing the lower orders of reflection of the long spacing. The distance between the third and fifth orders was measured, and from this the spacing was calculated.

The data obtained with the odd acids, which behave differently in general from the even acids, are summarised in the following table:

Acid.	Melting Point.	Transition Point.	Spacing of the Modification.		
			At Lower Temp.		At Higher Temp.
			β_I	β_{II}	α
$C_{11}H_{22}O_2$	28.2	17	30.1	..	25.4
$C_{13}H_{26}O_2$	41.2	32	35.1	31.5	29.8
$C_{15}H_{30}O_2$	52.1	44	39.7	35.9	34.4
$C_{17}H_{34}O_2$	60.6	54	..	40.2	38.7

At the transition point, the β -modifications pass into the α -modification and vice versa.

The presence of two β -modifications in the table needs some further explanation:

At the lower temperature, in the case of C_{11} and C_{13} , all specimens showed the ' β_I -spacing,' whereas films of C_{15} and C_{17} always showed the ' β_{II} -spacing.' It was possible, however, to obtain in some ways films of C_{13} showing not only the β_I - but also the β_{II} -spacing, and films of C_{15} showing, besides the β_{II} -spacing, also the β_I -spacing. When these films, however, after first being transformed into the α -modification, were again cooled down below the transition temperature,

the α -lines of course disappeared, but only lines due to one β -modification reappeared. In the case of C_{13} this was the β_I -modification, in the case of C_{15} the β_{II} -modification.

From this we may conclude that the β_I -modification is the stable one of C_{13} and the β_{II} - of C_{15} . It must be observed, however, that heating the preparation for several hours at about 2° below the transition point did not seem to have any influence on the relative intensities of the lines due to the two β -spacings. This proves that if it should be possible to transform immediately the less stable form into the

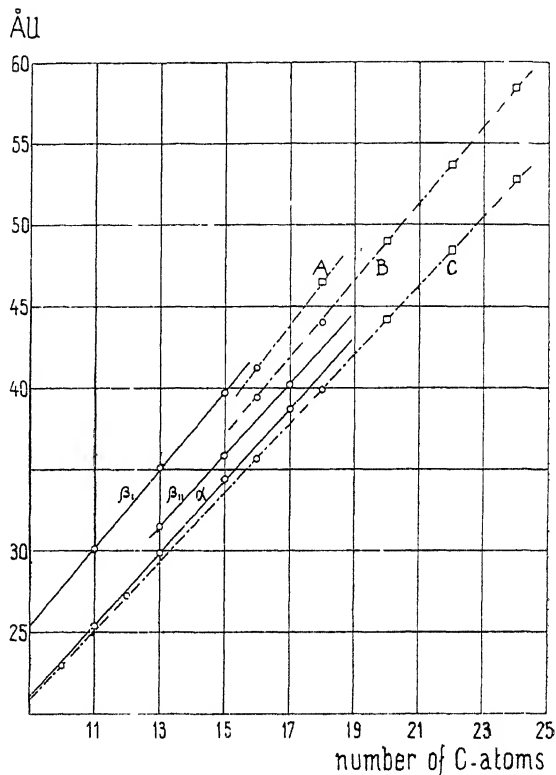


Fig. 1.—Spacing constants as a function of the number of C-atoms of the molecule. The dotted lines relate to the even acids, and the continuous lines to the odd acids.

more stable one, the rate of this transformation at least must be very slow.

Though several trials were made under different conditions, I never succeeded in observing a β_{II} -modification of C_{11} or a β_I -modification of C_{17} .

For some of the even fatty acids Piper has found three different modifications at room temperature which he calls A-, B-, and C-modifications. According to Piper, these modifications are independent of the temperature, their occurrence depending only on the way the preparation is obtained.

In the present investigation, however, I could show that these modifications are also influenced in a certain way by temperature. For example, starting with a preparation of palmitic acid, which showed at room temperature three modifications at the same time (spacings A 41.2; B 39.5; C 35.8 Å.U.) and heating at 45° for three hours, the B-lines had nearly disappeared, the A-lines persisted in about the same intensity, whereas the C-lines had much increased. Raising the temperature to 50° for two hours, the A- and B-lines both had wholly disappeared, whereas only C-lines appeared on the plate. Raising again

the temperature to 59°, no further changes occurred. On cooling down again to room temperature, a photograph was obtained identical with that at 59°; no A or B spacing reappeared. In the case of stearic acid, starting with a film which showed only the B-lines at room temperature, after heating to 55° only the C-lines were observed. In the case of capric and lauric acid, only the C-modification was found at room temperature, which remained unchanged when heating at some degrees below the melting temperature.

Thus the even fatty acids seem to have only monotropic modifications of which the C-modification is the stable one.

In the accompanying diagram (Fig. 1) the spacings observed are plotted against the number of carbon atoms of the corresponding molecule. So far there seems to be no simple relation between the spacings of the even and the odd acids.

Our results seem to confirm some suggestions already given by Garner (Garner, Madden, and Rushbrooke, *Jour. Chem. Soc.*, 1926; 2491).

I have to thank Mr. J. A. Prins for much helpful advice during the course of the work.

In conclusion, I wish to express my thanks to Prof. P. E. Verkade, of Rotterdam, for supplying several pure fatty acids, and to Prof. W. E. Garner, of London, who put some pure heptadecylic acid at my disposal.

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The Nuptial Pad of Kammerer's Water-bred Alytes.

SOME time ago a friend of mine who was interested in my amateurish experiments on frogs took some pictures which he intended for publication. He found it necessary to bring out some of the natural markings with ink so that they would reproduce better in print. I am wondering if the marking of Kammerer's specimens which led to his suicide might not have an equally simple explanation.

WALTER C. KIPLINGER.

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KAMMERER's untimely death has confronted us with three problems, seeming intrinsically interwoven, but, as it appears now, distinct enough to be dealt with separately: they are—

(1) The motives of his suicide; (2) the mystery of the 'doctored' specimen; (3) the validity of the original experiments on the nuptial pads in Alytes.

The first question is chiefly psychological, the second criminal, while only the third concerns biological science proper. Whilst we can conjecture the motives of Kammerer's weariness of life (see *Monistische Monatshefte*, 11, 401, Nov. 1926; R. Wettstein, *Neue Freie Presse*, Dec. 16, 1926), we are at a loss as to the person who may have injected specimens with Indian ink or with what intention this may have been done. It seems not impossible that Mr. W. C. Kiplinger's suggestion is correct and that the injection was intended to enhance a faded appearance in order to get a good photograph, although the existence of other doctored specimens does not seem to be in favour of this version. A picture was taken in September 1922, not in the Biologische Versuchsanstalt, but in the photographic studio Reiffenstein, of the well-known specimen, and only from thence onwards do the mis-statements begin. On the other hand, up to 1919 the descriptions and figures of

nuptial pads in Alytes given by Kammerer do not fit in with this specimen. We are therefore able to exempt any one who died before 1919, or had no contact with the Institute after that year, from any suspicion at having made the injection; for example, Dr. F. Megušsar, who was killed at the Wolhynian front on Aug. 3, 1916 (see *Archiv für Entwickl.-mech.*, 42, 222; 1917).

We have been able to collect five proofs that in his original papers Kammerer was not hampered by the doctored specimen which has invalidated his remarks on the same subject in his books "Inheritance of Acquired Characteristics" (1924) and "Neuvererbung" (1925). By comparing dates and photographs we can now formulate these proofs even before the new experimental evidence which Kammerer's collaborators in Moscow are trying to get is available: the proofs are as follows:

(1) In Kammerer's original papers the nuptial pad in Alytes is described and pictured as being "on the dorsal side of the thumb and on the thumb-ball" (1909, p. 516, fig. 26a), "on the dorsal and radial side of the first fingers" (1919, p. 336), and "across the thumb-ball on the whole internal side of the fore-arm to near the elbow" (p. 337, tb. x, fig. 2), in accord with the general appearance of nuptial pads. Even in 1923, when Kammerer showed a lantern slide of the critical specimen before the Zoological Society of London, he did not mention the disposition of the nuptial pad on the whole palm of the hand (see Bateson, *NATURE*, Dec. 22, 1923, and letter to Przibram). It was not until the photographs of this specimen were used in his books (1924, p. 53, fig. 9 to the right; 1925, fig. 9, facing p. 20) that Kammerer mentions and defends the untoward position of the pad in the palm and on the outer border of the last (fourth) finger.

(2) The photograph in his original paper (1919, tb. x, fig. 2), taken by E. B. Congdon (see *ib.* p. 369) in Kammerer's and my presence in 1913 (letter of Congdon, professor at the Chulalongkara Medical School, Bangkok, Jan. 8, 1927), shows a narcotised Alytes with nuptial pads on the radial side of hand and arm.

(3) The drawings by Kaspar of microtome sections (Kammerer, 1919, p. 370, tb. 11, figs. 7, 9), and the photos thereof by Prof. H. Joseph (*ib.* tb. 10, fig. 4), relate to skin taken in 1913 (see *ib.* p. 331) from the hands of Alytes in Kammerer's presence by Olga Kermauner, sister of Prof. Kermauner, of the University of Vienna, now married to Mr. Critikos. This lady histologist herself prepared all the slides and remembers having been struck by the difference in those of the water-bred Alytes as compared with the normals from the beginning (letter by Mrs. Olga Critikos, 914 Leland Ave., Chicago, Dec. 15, 1926).

(4) Comparing the known forms of nuptial pads in other species as to their horny spicules (Lataste, Meisenheimer, Harms, Kändler, etc.) with these drawings and photos of Alytes, there seems to be full specificity of these structures. Even the sections of *Bombina maxima*, the nearest approach to Alytes, can easily be distinguished from the photographs and drawings which Dr. Noble (Museum, New York) has sent me. The species *B. maxima* was not known to Kammerer and has never been kept alive at our Institute (see list of animals, *Zeitschrift biol. Technik u. Methodik*, 3, 163; 1913, p. 214).

(5) The histological features of Kammerer's sections of nuptial pads in Alytes are furthermore identical with those of a specimen found in *Nature* by R. Kändler (*Jenaische Zeitschrift*, 60, 175; 1924, tb. x, fig. 12) with rudimentary nuptial pads. The stratification and relative nuclear sizes of the said sections

are also exactly duplicated by those of sections taken from normal Alytes (Kammerer, 1919, tab. 11, figs. 1, 2, and photographs sent by Dr. Noble).

These five proofs being each conclusive and independent of each other, I should think the nuptial pads in water-bred Alytes must be seriously taken into consideration, unless some one should offer another explanation of the coincidence of the five points raised here.

HANS PRZIBRAM.

Vienna II., Prater,
Vivarium, Mar. 26.

Science and Food Production.

In the very sympathetic notice of my book, "Plant Nutrition and Crop Production," in NATURE of Mar. 26, p. 454, the reviewer raises the interesting question how far science has actually helped in increasing the production of food. Statistics show that, in spite of the scientific work, the yield of wheat per acre in England is not much greater than it was fifty years ago, and it is implied that scientific work has in practice achieved little, however interesting its results may have been from other points of view.

The statement is partly true, but the conclusion is entirely wrong. There are several ways in which food production may be assisted by science, among them: (1) increasing the output per acre of land, (2) increasing the output per man-hour of labour, (3) increasing the area of cultivated land. The great development of transport during the past fifty years led to the opening up of new countries, and made the third of these possibilities the easiest; it was consequently adopted. The extension in area of cultivated land has proceeded *pari passu* with the growth of the population, and there are still, as there were fifty years ago, some two acres of cultivated land for each civilised human being. There has been no pressing necessity, and therefore no economic inducement, to increase output per acre.

The great increase in rates of farm wages, however, has compelled an increased output per man-hour of labour, and this has been accomplished. In 1881 on a farm of careful management and careful records it took 117 man-hours to grow one ton of wheat; in 1921 only 82 hours were needed. Equally marked changes have taken place in the root crops.

Further, science has greatly increased the certainty of crop yields: catastrophes are things of the past. In 1844 potato blight came to the British Isles, and for forty years its depredations were almost unchecked. It caused the appalling Irish famine of 1845-46, and between 1877 and 1880 its damage in Ireland alone was estimated at £20,000,000. The committee of inquiry set up in 1880 reported that all witnesses, scientific and practical, believed it to be hopeless to prevent the spread of the disease once it had set in.

All this is changed: an effective fungicide now keeps the disease in bounds so that it is no longer feared.

By common consent the worst season of the last century for the wheat crop was 1879, when the persistent wetness and high rainfall completely baffled the farmers of Great Britain. The financial losses were appalling, and the season was long remembered with dread in the countryside. During the present century there have already been three years of higher rainfall, 1903, 1912, and 1924, than 1879, but there was no agricultural crisis. Of course there were losses, but they did not compare with those of 1879, and they are already almost forgotten.

The statement, frequently made, that yields have not increased, is only partially true. Wheat is

commonly taken as the test crop, but this is unfair. It was formerly the most important crop on the farm, but now it is much less important. The high yields of fifty years ago were attained by abundance of cheap labour; to-day this method is not available. New methods have been devised which pay the labourer several times the old wages and which yield at least as much produce per acre. More direct comparison can be made by taking crops in which we have been self-supporting over the whole period and for which therefore the relative importance in the farm economy has not diminished. Precise statistics of average yields are difficult to obtain, but trustworthy experts fifty years ago put the yield of potatoes at about 6½ tons per acre under good farming conditions. Now, however, a good farmer would expect 10 tons per acre, and could reasonably hope for more. Similar increases can be recorded for some of the fruit and market garden crops, as well as the important cucumber and tomato crops.

It is freely admitted, of course, that science has not been the only factor at work. The makers of implements, and fertilisers and feeding-stuffs, seedsmen, the country school teacher, and the farmers themselves have all played their part, but it is impossible to deny that science has largely contributed to the result.

Finally, scientific work has demonstrated that this intensification of production is possible for all farm produce. At the present time much of the knowledge remains unused in regard to certain items such as wheat, lower qualities of meat, etc., because the alternative method of increasing the area of cultivated land still remains open and is cheaper. But obviously this will not always be the position, and it is perhaps the crowning achievement of agricultural science that it is steadily working at methods of intensification, knowledge of which will be imperative directly the area of cultivated land has reached its limit.

E. J. RUSSELL.

Rothamsted Experimental Station,
Harpenden, Herts.

It was far from my intention to suggest that science, generally, had failed to help in increasing the production of food, and least of all to base such an assertion on official statistics of the average yield of wheat. If Sir John Russell had heard Venn's smashing indictment of official underestimating, delivered last year at Oxford, he would not tilt at that windmill. All I need plead guilty to is extreme sympathy with the view that the value of science is not merely materialistic; but until this sympathy is more universal than it is now, the unenlightened public will not cease to clamour for more spectacular results than agricultural science, in its 'slow and painful' progress, has produced in the last fifty years.

THE REVIEWER.

The Sleep of Whales.

VERY little is known about the sleep of whales. They seldom sleep at the surface. Scoresby, speaking of the Greenland whale, says: "Whales are seldom found sleeping, yet instances occasionally occur, in calm weather, amongst ice." I have in my possession a large number of log-books of whaling voyages to the Greenland Sea and do not find a single example recorded. The recently published log-books of Capt. Scoresby, senior, tell the same tale.

Years ago I made a number of voyages to the Greenland Sea with my father, the late Capt. Gray, of Peterhead. On one occasion when we were amongst the ice, and it was my duty to be in the crow's nest, I

discovered, with the aid of a telescope, a dark stationary object in the water a few miles away. It proved to be the 'crown' (i.e. the highest part of the head) of a Greenland whale asleep. It was on the far side of a large field of ice, and as the wind was light, our ship was two or three hours in reaching it. When we came to it we lowered two boats, one of which pulled towards it and harpooned it.

A few years later we again came across a Greenland whale asleep. This time our ship was anchored to a large floe; the whale was again sighted from the crow's nest, and it fell to my lot to attack it. Pulling for a few miles along the edge of the floe, we came in sight of the sleeping whale. We approached it from behind, as quietly as possible, and before firing the harpoon gun I allowed the boat to run towards it until the bow was over its tail and the stern was almost touching its back. Before the whale left the surface I saw that the harpoon was buried in its back.

I had an excellent opportunity of seeing both these whales. In both cases they lay motionless at the surface from the time they were first sighted until attacked. In both, the 'crown' on which the blow-holes are situated was out of the water, and the back slightly so or awash. Neither of them appeared to be breathing and neither gave any signs of life until harpooned. Their slumber appeared to be very profound.

I remember being told that sleeping whales when suddenly awakened by the harpoon sometimes beat the water with their fins and tail, instead of immediately leaving the surface. For this reason, in the case of a sleeping whale, the attacking boat ran some risk, and in the days of the hand harpoon, when it was necessary to approach very close to the whale, it was usual to awaken it first by tapping on the wood-work of the boat. No harm resulted to the attacking boats in the above instances, but I should have mentioned that the first whale was awakened (but fortunately not alarmed) by a slight ripple that proceeded from the ship's bow before the boat reached it, and that the other did strike the water once violently with its tail but without harming the boat.

It was also my good fortune one voyage to see and harpoon a narwhal asleep, but as the incident is described in the *Zoologist*, 1889, page 100, there is no need to refer to it at length here. As in the Greenland whale, the narwhal when asleep lies motionless at the surface and gives no sign of life. Although these small whales are common amongst the ice, and although it was my duty to spend much time in the crow's nest, I do not remember seeing another asleep on any of my other voyages.

If whales seldom sleep at the surface, where do they usually do so?

The Greenland whalers believed that the Greenland whales sleep under the ice, and that they retired under it at regular intervals for the purpose. Scoresby Senior was of this opinion, and even sent his men on to the ice to awaken them. His celebrated son, a very cautious writer, contents himself with stating: "Some persons are of opinion that whales [i.e. Greenland whales] can remain at the bottom of the sea in shallow water, when undisturbed, for hours at a time." According to my father, who had a life-long experience and had opportunities of watching sleeping whales, "the Greenland whale does not require to breathe while asleep and does not do so" (Seventh Annual Report of Scottish Fishery Board, part 3, p. 367).

How are the foregoing observations to be reconciled with what is known of the physiology of whales? What is the explanation?

It is obvious that sleep is as essential to whales as

to other animals; that the access of water to the lungs must be guarded against at all costs, and that there is a limit to the time they can live without air. It is also obvious that if whales can remain under water for an hour or more when harpooned and exerting themselves to escape, they can do so for very much longer when their voluntary muscles are at rest. I venture to suggest that whales when asleep awaken to breathe at intervals; that after breathing they relapse into a profound slumber; that the blow-holes are tightly closed during sleep (as indeed appeared to be the case) so as to make it impossible for water to enter the respiratory passages, and that they (the blow-holes) are not necessarily or even usually above water during sleep; that whales usually sleep below the surface hidden from observation and undisturbed by wave motion, but that they rise to the surface at intervals to breathe. In what other way can the facts be explained? I am not prepared to say how long the Greenland whale can sleep without breathing, but it certainly appears to be a long time from what I saw.

I have to add by way of a postscript that we sometimes came across quantities of stringy mucous floating on the surface of the water amongst the ice. According to my father, who called them 'blowings,' they are discharged from the blow-holes of whales, but whether they consist of mucous that accumulates during sleep and is discharged when they awake or is merely evidence of a catarrhal condition, I am unable to state.

ROBERT W. GRAY.

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Exmouth, Devon.

Florentium or Illinium?

IN a recent issue of *NATURE* (Feb. 26), and also in *Science*, Prof. W. A. Noyes writes claiming priority for the discovery of the element No. 61 for the American chemists, Messrs. Harris, Hopkins, and Yntema. As an argument in favour of this priority two papers are quoted: one by C. C. Kiess (U.S. Bureau of Standards, 442; 1922; 446; 1923), and the second one by L. F. Yntema, which appeared in 1922 and 1923 respectively.

The first author has accurately studied the arc-spectra of neodymium and samarium, using pure materials supplied by Prof. Hopkins of the University of Illinois. During this research C. C. Kiess found many lines in the visible spectrum common both to neodymium and samarium and of unknown origin. He considers the possibility of these lines belonging to a new element and, following Moseley's rule, since a new element of atomic number 61 should occur between neodymium and samarium, Kiess infers the new element to be No. 61. L. F. Yntema (*Jour. Amer. Chem. Soc.*, 46, 37; 1924) examined the spectra of the same material in the ultra-violet, and he too found five lines not yet classified. Considering then the possibility that these lines could belong to a new element of atomic number 61, he made an X-ray investigation of the *K*-absorption spectra, using de Broglie's method, as well as of the *L*-emission spectra: in both cases he had a completely negative result. The conclusion of Yntema's paper may be quoted: "X-ray analysis of samples from different sources has so far given no evidence of the presence of this element."

In the study of emission spectra in the visible and in the ultra-violet, it is not sufficient evidence for assuming the existence of a new element, to have found lines common both to neodymium and samarium and yet unknown, because the emission spectra of these elements are extremely complicated and uncertain, and also because it is not easy to be perfectly

sure about the spectroscopic purity of the material used. These have been the chief reasons why for many years, before Moseley's discovery of the possible number of elements, it was believed that new elements had been discovered only from the fact of having seen new spectral lines. Some of these elements have been really found afterwards, but in this case the discovery did not belong only to those who had noticed the spectral anomalies; the non-existence of other of these supposed elements was proved on further examination.

Indeed, about the homogeneity of the elements composing the old didymium there have been for many years numerous discussions after Auer v. Welsbach succeeded, in 1885, in separating neodymium from praseodymium; many experimenters tried to show the heterogeneity of the new elements. In 1886, Crookes (*Proc. Roy. Soc.*, 40, 502; 1886) affirms that the two didymia are complex, and so too Demarçay (*C. R. Acad. Sci.*, 102, 1551; 1886; 105, 276; 1887), Becquerel (*C. R. Acad. Sci.*, 104, 777; 1887; 104, 1691; 1887), G. M. Tomson (*Chem. News*, 55, 227; 1887), Ksewetter (*Ber. Chem. Ges.*, 21, 2310; 1888). Crookes and many others, starting from the anomalous behaviour of emission and absorption spectra, believed that didymium should contain at least one other new element. Kruss and Nilson (*Ber. Chem. Ges.*, 20, 2134; 1887) even stated that didymium and praseodymium were composed of at least nine elements.

In 1913, Moseley's rule removed any uncertainty from these researches, establishing that one and one element only ought really to be found in the didymia earths, and that to this element belonged the ordinal number 61. The merit for this improved prediction should be credited only to Moseley, who defined and circumscribed the field of research.

We believe, then, that the priority in the discovery of element No. 61 belongs instead to those who first had sure data as to its existence, and in similar cases sure evidence cannot be obtained except by means of X-ray investigations. While L. F. Yntema published the negative results of his research in this field, we obtained (X-ray measurements were made by Prof. R. Brunetti) the first photographs of K-absorption spectra showing the characteristic band of element 61 and, a few months after, we collected our results in two papers deposited, as *plico suggellato*, at the Accademia dei Lincei. These contained the first certain data, therefore we believe that we should be credited with priority for the discovery.

As regards Prof. Noyes' remark upon the priority of name, we would point out that the name Florentium was given by us in June 1924, a year and eight months before the paper referring to the name Illinium appeared. We are, on the other hand, perfectly in agreement with Prof. Noyes that much additional work has still to be done on the subject, and we hope that the combined effort of researches will, in a short time, bring about the undisputed acceptance of the new element.

L. ROLLA.
L. FERNANDES.

R. Università Firenze,
Via Gino Capponi, No. 3.
Mar. 21.

Transmission of Stimuli in Plants.

FOR two writers living in the East to carry on a correspondence in the columns of NATURE is a somewhat protracted process, but perhaps I may be permitted to reply to the remarks of Sir J. C. Bose (NATURE, Jan. 8) regarding a previous letter of mine (NATURE, Oct. 23, 1926).

It is interesting to note that Sir J. C. Bose now apparently accepts the fact, originally demonstrated

by Dr. Ricca, that in Mimosa the excitation induced by a flame can be transmitted across a water-gap.

The importance of this fundamental experiment is quite unaffected by any amount of experimental evidence which may appear to show that the phenomena associated with the transmission of stimuli are closely similar in the plant and in the animal. It is not really essential to show that the excitation induced by every kind of stimulus can similarly be transmitted across a water-gap, although, provided that the stimulus can be made sufficiently intense, there should not be any difficulty in affording the necessary proof. It must be remembered, however, that if only a small amount of hormone is set free, it would suffer so much dilution in passing through the water-gap that its stimulating power would be seriously diminished.

Some of the arguments used by Sir J. C. Bose against the transpiration current theory have little force. For example, he states that the impulse should only travel upwards in the same direction as the ascent of sap. Movement in either direction is readily explained by the generally accepted theory of the ascent of sap put forward by Dixon and Joly, and can easily be demonstrated by cutting the plant under stain. At the same time it must be admitted that, although Dr. Ricca's theory undoubtedly explains many of the normal instances of conduction in Mimosa, it does not afford a complete explanation in every case. In submerged shoots, for example, where the transpiration current is almost negligible, stimuli may be conducted through long distances in the stem at a rate of more than 200 cm. per minute. In a paper which I hope will be published early this year, I have suggested that in such cases the transport of the stimulus takes place as a result of the contraction of highly turgid cells. At the point where the stimulus is applied, certain of the cells contract and liberate a stimulating substance. This affects neighbouring cells, which in turn liberate more of this substance, and so the process goes on. For the experimental evidence on which this theory is based, I must refer Sir J. C. Bose to the complete paper, but I may mention that it appears to afford an explanation for those cases where, as already pointed out by Mr. R. Snow, the transpiration current theory is inadequate.

The evidence which Sir J. C. Bose has brought forward in favour of his own theory is well known and is extremely interesting. Even if one holds the view that the conduction of stimuli in Mimosa takes place apart from any nervous mechanism, it is still necessary to consider certain of the phenomena associated with electrical stimulation. It seems probable that these may be explained in other ways, although, at the present state of our knowledge of the factors involved, this may be difficult. If, however, it is finally proved that there are certain facts which cannot be explained by any other hypothesis, then, and then only, shall we be justified in accepting a nervous mechanism as one of the methods by which stimuli are transmitted in plants.

NIGEL G. BAILL.

University College, Colombo,
Feb. 3.

River Pollution and the Acidity of Natural Waters.

IN "Fundamental Problems relating to River Pollution" (NATURE, Mar. 26, p. 463), Mr. H. W. Harvey mentions the probable effect of the hydrogen ion concentration on river flora and fauna, and suggests that possibly pH 5.5 is a critical value.

It seems probable that, as regards fish life, acclimation may be an important factor and that

possibly fish habituated to acid conditions may readily tolerate a degree of acidity which would be very deleterious, if not fatal, to others reared in, and accustomed to, neutral and alkaline water. The burns and lochs of the Scottish highlands are largely in peat and igneous rock; limestone exists only in small areas and in isolated districts. The water supply coming from peat is essentially acid in character, and in surface drains and pools the pH value may be no more than 3 or 4: clear springs coming through the 'pan' under the peat have been found to be pH 4.5, while in a peat surrounded loch of the same water value trout, averaging $\frac{3}{4}$ lb. in weight, flourished. Both trout and salmon will leave a burn having water of pH 6 for another and smaller of pH 5 in order to spawn. In similar peat districts with a limestone formation, however, the acidity is lessened or neutralised and the burns vary from pH 6 to pH 7.5.

Such acid conditions as prevail in the typical peat district may perhaps affect the nature of the flora and may possibly restrict the fauna, but both trout and salmon parr can, and undoubtedly do, thrive in water of pH 4.5 to pH 6.

W. J. M. MENZIES.

Fishery Board for Scotland,
Edinburgh, Mar. 30.

A Useful Electric Cell.

TAKE a glass vessel, a porous cell, a zinc rod and a carbon plate, such as are used in the ordinary Leclanché cell (a circular glass vessel of the same capacity is better). Prepare a solution of 20.4 grams of potassium dichromate and 87.4 grams of sulphuric acid (sp. gr. 1.75) in 350 grams of water and pour it into the glass vessel. Place the carbon plate in this solution. Fill the porous cell with a solution of 14.5 gm. of ammonium chloride in 200 gm. of water and place it in the glass vessel containing the dichromate solution. The amalgamated zinc rod is placed in the porous cell. The E.M.F. of this cell is 2 volts. The internal resistance is about 0.6 to 0.8 ohm. When continuously used, it gives a constant current for more than 12 hours, and the E.M.F. remains unchanged. The rate of dissolution of zinc (when a rod of zinc is used) is only 2.5 gm. in 12 hours, while in the bichromate cell the rate is 12 gm. When used intermittently, the cell remains efficient for more than three weeks.

S. L. JINDAL.

D.A.V. College Laboratory,
Cawnpore, Feb. 24.

Biological Fact and Theory.

PROF. WALKER in NATURE of Mar. 26, p. 456, introduces personalities into his reply to my letter. In the circumstances, I do not wish to continue a discussion intended to deal with the purely scientific issue of whether Prof. Noël Paton's attack on accepted genetic theory was justified.

I would, however, like to repeat the statement with which I began, namely, that the progress of biology in Great Britain is being retarded by the failure of specialists in its various branches to appreciate the bearings of work done in other fields than their own. With regard to the specific point at issue, Prof. Walker writes that he has watched "often with amazement, sometimes with amusement," the attempts of geneticists "to make the 'neo-Mendelian' 'laws' agree with the results of breeding experiments." What must a physicist think of biology and biological theory when he reads this? In physics, at least, the prime aim of the man of science is to make his theories fit the facts of Nature. One's comfort is that, with few and negligible exceptions, the whole body of those engaged upon genetical research are

actually employing the conceptions and theories which I enumerated, and which Profs. Paton and Walker repudiate, as a means to the discovery of new and fruitful facts.

JULIAN S. HUXLEY.

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London, W.C.2.

The Development of Natural History Museums.

OPENING NATURE of April 16 at p. 551, I am astounded to read: "What has the Natural History Museum . . . done to make Darwin's . . . discoveries current amongst his own people? . . . Nothing! Except for a few isolated exhibits, shown almost in holes and corners. . ."

When you favour this Museum with a visit you will doubtless observe the statue of Darwin in the place of honour, looking down on a Hall in which are conspicuous cases illustrating such subjects as variation under domestication and in Nature, protective coloration, mimicry, intergradations between species—cases which, I may remark, set an example to the world.

If you will then do me the honour to enter the Geological Department, the very first label (a large one, next the door) you will find explains evolution in Proboscidea, while the relevant specimens face you on entry. If you will kindly follow me into Gallery VIII you will speedily be brought up by an exhibit in a large central case elucidating evolution, convergence, and adaptation in some stalked echinoderms; farther on is one illustrating evolution in the sea-urchin *Micraster*. The cases devoted to Polyzoa illustrate growth and evolution in a colonial organism. Returning, you cannot miss the classical instances of the Steinheim Planorbis, the Viviparus of Slavonia, and the *Melanopsis* of Hungary.

You could see more examples in other galleries, but that is enough for one visit. Let me, however, remind you that similar exhibits prepared and arranged by the staff of the Museum have been shown at the White City and at Wembley in several years. Guides to the Geological Department have been praised for their connecting thread of evolutionary philosophy. Towards that philosophy of recent years one of the most important contributions has been the catalogue of fossil Polyzoa, notably the volumes by Dr. Lang.

With much that you say I am in hearty agreement. But if you wish for reforms you will not get them if you begin by antagonising those who are working all day and every day to put those reforms into actual practice. Let me assure you that the combination of accuracy and order with imagination and breadth of view is not impossible, even in a museum official: certainly it should not be impossible in a leading article of our chief scientific paper.

F. A. BATHER.

Natural History Museum.

DR. BATHER's comments surely support our plea for a more educative and effective arrangement of exhibits of fundamental biological importance. Under his skilled guidance several such exhibits may be discovered, but to the ordinary intelligent visitor, who may lack such guidance, they are for the most part lost in the systematic arrangements to which they are subordinated, and if discovered can make only an isolated and non-cumulative appeal. Our comments, however, were not meant as hostile criticism, for probably as much has been accomplished as the conditions allow; we endeavoured to indicate that, under present conditions, it is difficult or impossible to keep the exhibits abreast of the modern scientific and educational outlook, and that this, with other factors, pointed to the desirability of an inquiry into the position as a whole.

THE WRITER OF THE ARTICLE.

Proposed Review of the Mineral Resources of the British Empire.¹

By Sir THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., F.R.S.

IN general terms the mineral production and metallurgical activities of the British Empire are already known; but no one has measured a base-line with sufficient precision for projecting with confidence the probable effects of further prospecting and future exploitation, coincident with the growth of metallurgical science, not only on the Empire as a whole, but also on each independent unit of Imperial territory.

War stresses demonstrated that the Empire is in reality a *political* unit, and, because of the strength and efficiency of the navy, its resources were then worked successfully as a *military* unit. But we all know that it is still far from being an *economic* unit, and it is conceivable that military developments in the near future may make it difficult, perhaps impossible, for the mineral resources of all parts to be assembled for any purpose.

Great Britain is at present the chief manufacturing section of the Empire, and it consequently will remain for many years to come the principal arsenal and base for stores of most sorts. In order to be precise regarding the mineral supplies that can be relied on in any contingency, it is necessary to have exact details regarding the resources of each isolated unit of territory; for there are many essential munitions—animal and vegetable as well as mineral—that Great Britain itself cannot supply, either in the right kind or in the requisite quantity.

In mentioning military requirements, I do not refer to munitions in the narrow popular sense as lethal munitions. They form only a fraction of the supplies that are essential to an army in the field. What a soldier wants on active service under modern conditions may differ largely in form, but agrees very nearly in substance, with what he wants during ordinary peace-time civilised life; and whilst the A.I. extract of young men is in the field, the larger insoluble residue of the population insists on its accustomed food, clothing, business, and amusements at home. The maintenance of the *morale* of a modern civilised community requires of raw materials and manufactured products the same kind that is necessary for the fighting army, but in a much larger quantity.

Thus, the economic and military problems of supply are not very different in nature: the fighting strength of a nation is limited by its industrial strength, and its industrial existence depends on the maintenance of a sufficient supply of raw materials.

There are, however, some raw materials that a country, for commercial reasons, often neglects under normal industrial conditions: its requirements of the articles manufactured from such materials can be obtained from other countries ordinarily in circumstances so favourable that the local establishment of manufacture may not be worth while commercially. For example, before the War, the wolfram deposits in South Burma were worked mainly by British companies, but

practically the whole of the mineral went to Germany for the manufacture of tungsten; and then, although Sheffield occupied about the front place among manufacturers of high-speed tool-steel, its tungsten was obtained from Germany. Attempts made before the War to smelt tungsten in Great Britain had not been commercially successful; and at the time, that seemed to be a small matter, for we readily obtained all the tungsten we wanted from Germany, and Germany obtained all the ore she wanted from British territory. With the War, however, two inconveniences followed in order. First, we had to devise our own plant for smelting tungsten, and, under compulsion of necessity, we succeeded before the middle of 1915. Second, Germany found herself without tungsten ore, and that proved naturally to be more serious; for, although she obtained some molybdenum from Norway as a substitute, it was not exactly the same thing; and even this new move was countered by British purchases of the Norwegian output of molybdenic ores.

Three lessons can be stated at once from this example:

(1) Whilst the military authorities of Britain may rely on our ordinary industrial complex for nine-tenths of their requirements, it is their business to see that the essential tenth is secured, and they cannot identify that tenth unless we provide full information regarding our resources.

(2) It is *important* to be sure that we can smelt as well as mine an essential ore; technical progress in mining and metallurgy in Great Britain must keep pace with the prospective developments of other nations.

(3) It is absolutely *essential* to be sure that we can get access to supplies of the necessary ores.

Germany rushed into a war that she expected to be over in a few months; she made the mistake of thinking she had sufficient reserves of tungsten ore. We made no mistake in that direction; for apparently the British General Staff did not think at all of a matter so small. Between 1911, when war was seriously threatened, and 1914, when it became unavoidable, efforts were devoted with conspicuous success to the training of an army that gave a new meaning to the word 'contemptible'; but who thought it necessary to provide for the smelting of an inconspicuous metal like tungsten, either in Britain or in British territory?

I have quoted the recent War conditions as the basis for our lesson, because the results were sharp and demonstrable, as well as still fresh in our memories. The way in which Germany was embarrassed by the blockade is a warning of what may happen if, by more effective means for cutting communications in the future, Britain becomes isolated, or, more likely, one of the outlying Dominions becomes blockaded in a future war.

Great Britain is so obviously unable to provide many essential raw materials in sufficient quantities, even under peace conditions, that to show by a

¹ From a paper read on April 21 before the Institution of Mining and Metallurgy.

detailed survey that she may be short of another mineral or two will not add much to the responsibility; but it is important to make estimates of the resources of each Dominion, and, separately, for groups of them and the Colonies—the minerals that each can mine and smelt, the ways in which each can supply the needs of others, the kinds that each can draw from adjoining foreign territory, and the amounts of the smaller, but necessary, mineral products that each should accumulate as stocks to draw on in a temporary emergency. Most nations carry stocks of gold and some of silver, but why not antimony, nickel, tungsten, and quicksilver as well? If isolated, could any Dominion, except Australia, meet its requirements in antimony? Could any country, except Canada, provide enough nickel? Could any part of the British Empire raise its own mercury? Yet, it would be less expensive to accumulate stocks of these sufficient for a few years' requirements than to buy a battleship; for a battleship is expensive to maintain, it gets quickly out-of-date, and it would be of little use in any event without supplies of most of these metals. Stocks of some metals are desirable also from the economic point of view, as they can be used to prevent speculative changes in prices.

Production figures give us a partial idea of resources; but something far more complete than this is necessary in devising a fiscal policy within the Empire itself, and *vis-à-vis* the rest of the world. The major mineral products are naturally those of most public concern from the economic point of view, but what we regard as minor and accessory minerals in times of peace may become vitally, or, more correctly, fatally, important under conditions of war.

Statistics of current production form an essential basis on which to design an economic policy, but they are unsatisfying in two important respects: (1) They do not reveal a country's resources in those minerals that could be exploited if and when necessary, but are not now worked under those commercial conditions that have developed by existing fiscal regulations; and (2) they do not give us an idea of the reserves available for future exploitation.

No other country has been more thorough than the United States in accumulating and publishing figures for production. Yet, in spite of these advantages, the international, and consequently political, aspects of mining and metallurgy, which arose directly from war and post-war conditions, remained to a certain extent neglected. In 1921 the Mining and Metallurgical Society of America combined with the American Institute of Mining and Metallurgical Engineers to establish a joint committee, under the chairmanship of Prof. C. K. Leith, to survey the problems of industrial preparedness in the United States; and this Committee on Foreign and Domestic Mining Policy first established a series of propositions, to be tested by a special sub-committee, for each important mineral.

The propositions² adopted by the Committee are summarised as follows:

(1) The international movements of certain minerals are inevitable, and although they may be hindered by fiscal barriers, they cannot under civilised conditions be stopped altogether. It is thus considered to be foolish to attempt by artificial restrictions to make any country self-contained: each should be allowed to benefit by drawing on the special advantages of others.

(2) Thus, in order to reduce transport expenses, concentration generally, followed according to circumstances by smelting or fabrication, should be accomplished near the source of supply.

(3) Prof. Leith and his colleagues plead for freedom for all nationals to prospect and exploit, and they urge that laws granting concessions should require that licensees of prospecting rights over large areas should be compelled, within reasonably short time, to narrow their claims for mining leases to areas that can be exploited effectively.

(4) Pressure on backward governments may be necessary to prevent them from shutting out those who are willing and able to develop mineral resources, of which they have surplus supplies, whilst industrial countries are suffering from deficiency; but any government using such pressure should observe the principle of the open door for all nationals.

(5) Government—that is, the United States Government—should improve the official intelligence agencies in foreign lands and so assist Americans with the information and help necessary for mineral enterprise abroad. There should be more attempts to obtain and correlate information regarding the world's resources in important minerals.

(6) The committee classified the known mineral deposits of the United States into:

(a) those that are obviously in quantities large enough to spare a surplus for export;

(b) those that just meet domestic needs, without excess or deficiency;

(c) those that exist in noticeably inadequate amounts; and

(d) those that the United States lack almost entirely.

The American assumption that we have nearly full knowledge of the distribution of mineral deposits of importance may be approximately accurate for the United States, but it would be unwise to apply it to Canada, to our African colonies, or to Australia. Possibly new discoveries in these areas will not disturb the world's supply of coal, manganese, iron ore, or petroleum in the near future, but it would be unwise to add copper and other relatively cheap base metals; in any of these partially explored areas there may well be deposits large enough and rich enough seriously to divert the present streams of the metal trade. Even the new discoveries of manganese on the Gold Coast threaten to change the source of supply of these ores.

However, it is useless to investigate our resources in minerals, and futile to discuss schemes to secure local smelting and refining, if the laws which control the grant of concessions for prospecting and mining add unduly to the cost of exploitation.

² "International Control of Minerals," New York, 1925, p. 7.

The conditions for mining change with the increase of transport facilities, with the development of new local markets, and with the growth generally of industries and technical science. Facilities of the kind that are necessary to encourage enterprise should thus be reviewed at reasonable intervals. No rules can hold good for longer than a few years, but their revision at frequent intervals tends to unsettle the confidence of business men, which of all bad policies is the worst.

It is the business of a mining company to make as much profit as possible out of a mineral deposit during the period of its mining lease; it is the business of government to safeguard a national asset of vital importance which cannot be replaced or renewed. But it is better for a country that its mineral deposits should be worked than that they should be left lying idle. The mineral policy of a government is thus the choice of a judicious mean between extravagance and conservatism; and, as the values of minerals vary with the industrial development of a country and that of the countries with which it is in trade communication, this judicious mean will gradually shift its position between the two extremes. Thus, the whole problem of framing and working a mineral policy for a large State is a choice of the judicious mean in all things—rents, royalties, periods of tenure, and size of areas leased.

There is a fundamental difference between State ownership of mineral rights and State ownership of mines, but there is a prevalent tendency, and therefore danger, of lumping both together as similar forms of Socialism, thus bringing them both into the arena of party politics. Legal doubts about security of tenure, absence of clear title to surface rights, local variations in length of lease and rate of royalty, the independent necessity of acquiring wayleaves and water-rights, are frequent accompaniments of the private ownership of minerals, and they all adversely influence the financier who is asked to underwrite a mining enterprise in an area in which he is not otherwise interested. The

end effect of these disadvantages is a handicap to the enterprise, which, like every other item of cost in mining, results in a loss to the State of some part of its mineral reserves.

The mining industry differs fundamentally from others: mineral deposits cannot be transplanted from one country to another; no nation, not even the British Empire, and much less any Dominion, is self-contained; minerals are essential for the maintenance of our commercial life and for military security; yet they can be worked once, and once only, in the history of a nation; the necessity for exchanging minerals between the Dominions involves the question of their fiscal interrelations; the necessity of exchange with other nations affects our foreign relationships. The importance of being safeguarded in mineral resources is only in a degree greater than the importance of being able to smelt our own ores.

There are good reasons, therefore, for classing mining with most of the public utility services, that is, as an industry that might be safeguarded by State action, without the intervention of party politicians or fear of doctrinaire Socialism.

Official and State-aided organisations already exist for the collection and publication of mineral statistics, but institutions of the sort, in order to retain the public trust in them for reference purposes, properly avoid the discussion of those conditions that affect finance and therefore the progress of exploitation. There are so many phases of the two complementary industries of mining and metallurgy which require a wide range of specialists for judicial consideration, that the task of making a survey of our mineral economics might be safely entrusted to those institutions at home and in the Dominions Overseas that have joined in organising the Empire Mining and Metallurgical Congress and Council. It is suggested that these institutions be invited forthwith to inaugurate special surveys for their appropriate territorial units, each being left to follow the plan that appears to it most suitable to the special conditions of its own Dominion and State.

The National Museum of Wales.

THE formal opening, by their Majesties the King and Queen, of the National Museum of Wales, took place at Cardiff on April 21, at a ceremony characterised by great dignity and splendour. Fifteen years ago their Majesties laid the foundation-stone of the building, and, in fulfilment of a hope expressed on that occasion, they graciously consented to open the first portion of the institution to be completed. Representatives from all parts of the Principality, embracing every side of the national life and thought of Wales, were present, while Mr. C. Tate Regan, Director of the British Museum (Natural History), and Mr. J. Charlton Deas, President of the Museums Association, represented the national and public museums of Great Britain.

Their Majesties were met on their arrival by Lord Kenyon, President of the National Museum of Wales, Lord Pontypridd, Lord Mostyn, Lord

Treowen, Lord Aberdare, Sir William Reardon Smith, the Treasurer of the Museum, and Dr. Cyril Fox, the Director. Mr. Dunbar Smith, the architect of the building, was presented to the King and asked His Majesty's acceptance of a mallet with which to perform the ceremony. Their Majesties then proceeded to the Entrance Hall of the building where the main ceremony took place. A loyal address on behalf of the Court of Governors and of the Council of the National Museum was read by Lord Kenyon and replied to by the King, after which the members of the Council of the Museum were presented to their Majesties. In the course of his reply to the address the King paid a well-merited tribute to the high ideals and achievements of the Museum, to the liberality of its benefactors, and to the wise planning and skilful designing of the building. He spoke of the valuable help the Museum could render by culti-

vating in the Welsh people a sense of beauty, a love of national scenery, and a pride in their nation's historic past, and by kindling a spirit of loyal service to its future welfare.

Under the guidance of the President and Director of the Museum, the King and Queen then made a tour of inspection of the building, in the course of which the King unveiled three tablets naming the Lord Glanely Gallery, the Pyke-Thompson Gallery, and the Reardon Smith Gallery, commemorating the principal benefactors.

Before and during the ceremony a delightful programme of music, under the direction of Sir Walford Davies, Mr. Warwick Braithwaite, and Mr. W. M. Williams, was given by a mixed choir of 300 voices drawn from choral societies all over Wales, the Cardiff Musical Society, the Romilly Choir, and the Cardiff Orchestra of the British Broadcasting Corporation. The occasion was a most auspicious one for this great Institution and a fitting inauguration for work of such first importance as that which it is seeking to do.

The idea of a National Museum for Wales was born more than thirty years ago, but the practical commencement of the scheme may be said to date back to 1903, when a resolution approving the scheme was moved in the House of Commons by the late Mr. William Jones, seconded by Mr. (now the Right Hon. Sir) J. Herbert Lewis and supported by Sir Alfred Thomas (now Lord Pontypridd). In 1905 a Special Committee of the Privy Council decided upon Cardiff as the most fitting locality for the Museum, and the Cardiff City Council allocated the magnificent site of five acres in Cathays Park on which the building is now in process of erection. The then existing Corporation Museum in Cardiff formed the nucleus of the national collection.

The Royal Charter establishing the Museum was granted in 1907, and in 1908 the first Director, the late Dr. W. Evans Hoyle, was appointed to the post. With characteristic energy, Dr. Hoyle threw himself into the work of preparing details of the requirements for the proposed building, and in 1910, after open competition, the design of Messrs. Smith and Brewer was accepted out of 130 competitors. The foundations of the south front and parts of the east and west wings were commenced

in 1911 and the foundation-stone was laid by the King and Queen in 1912. The War, unfortunately, necessitated the complete suspension of building operations when only about one-half of the superstructure was completed, and the adverse conditions of post-War years, with the increased cost of building which accompanied them, has delayed the completion of these first portions of the Museum until this year. Even now it has been possible to do so only through the magnificent gift of £21,000 from Sir William Reardon Smith, the Treasurer of the Museum, which enabled the Museum authorities to appeal to the people of Wales for funds to complete the superstructure commenced fifteen years ago.

The National Museum of Wales is one of the best-designed Museum buildings in existence. The wide knowledge of museum construction and requirements possessed by its first Director, to-

gether with the skill of a most understanding architect, have combined to produce a building of great beauty, strikingly individual in character, yet dignified and nobly proportioned, in which both exhibition galleries and workrooms have been successfully planned on the lines of the

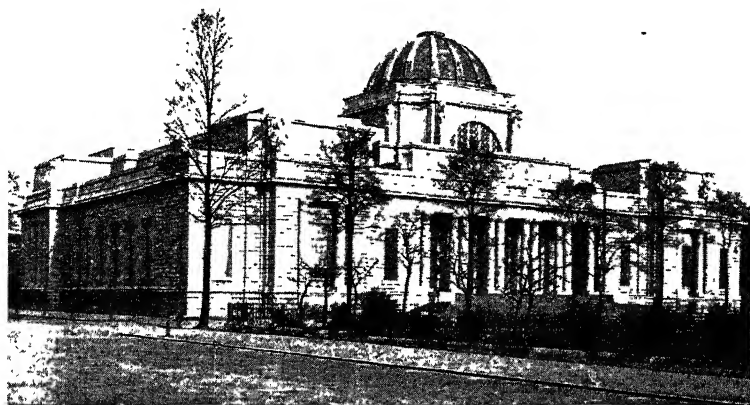


FIG. 1.—National Museum of Wales, Cardiff. Front view

most modern ideas of museum construction.

The entrance hall, the scene of Thursday's historic ceremony, is one of the chief glories of the building. It consists of a central octagon roofed by a lofty dome, with lateral bays extending the full width of the south front. The beauty of its great interior is of simple character arising out of structural necessities, fine proportions, adequate and well-placed lighting, and sound, beautiful craftsmanship.

The building opened by the King and Queen last Thursday represents little more than a quarter of the contemplated scheme. In it, however, separate galleries are available for zoology, botany, geology, archæology, oil paintings, water colours and prints, while the lateral bays off the entrance hall are to be devoted to sculpture, so that it is possible to lay down the general lines on which all sections of the institution will be developed.

The completion of this first portion has already had a stimulating effect. Lord Buckland has made a donation of £35,000, and Mr. Lewis

Lougher, M.P., one of £5000 towards the building fund, and, as these donations will be augmented by equal grants from the Treasury, it is hoped to make an early start with a further portion of the east wing, which will include a much-needed lecture theatre.

The purpose of the Museum has been aptly stated in the phrase, "To teach the world about Wales and the Welsh people about their own Fatherland," and it seeks to fulfil this purpose in

a large variety of widely spread activities. In the first place, it is actively engaged in the collection and preservation of all kinds of material bearing upon the archaeology, art, history, and natural history of the Principality, and presenting to the public a selected series of objects from this material in readily intelligible and attractive form, from which the story of the country in all its aspects can be studied. Secondly, it is doing a great deal of valuable educational work by means of lectures and demonstrations to schools, colleges, societies, and institutions of all kinds throughout Wales, and by an organised system of loan

collections, which are sent out to all parts of the country, especially to national organisations such as the Royal Eisteddfod and the Royal Agricultural shows. It encourages and works in close co-operation with local museums in all parts of Wales and helps them by means of loans and curatorial assistance. Through the medium of its printed guides and other publications, information regarding the contents of the Museum in the light of recent research is provided in convenient, popular, and strictly scientific form. It is a valuable

adjunct to the University of Wales, especially to the University College of Cardiff, the students of which make regular and frequent use of its resources in the prosecution of studies covered by its activities. Lastly, it is itself a research institution, and most valuable work has been done by the staff. Reference need only be made to the important excavations undertaken at Caerleon, Caerwent, and other important archaeological centres in Wales under the auspices of the Museum,

to realise that this important aspect of Museum work has been given a conspicuous place in its policy. Equally important, though perhaps less well known, research has been accomplished on the natural science side.

The Museum of Wales owes much to its first director, Dr. W. Evans Hoyle. It was he who conceived the broad lines of general policy on which the work of the Museum is based, and it is to his ripe experience of museum matters that the success of the institution as a museum must be attributed. His successors in office, Dr. R. E. Mortimer Wheeler and Dr. C. Fox,

have continued the tradition established by him. Under direction so able and with purpose so lofty, the success of the museum as a national institution, reflecting national life, ideals, and thought, is assured.

It is to be hoped that the stimulus of last Thursday's ceremony will result in the speedy completion of the whole building, so that the work of the Museum may go forward unhampered and unimpaired for want of adequate accommodation and facilities.

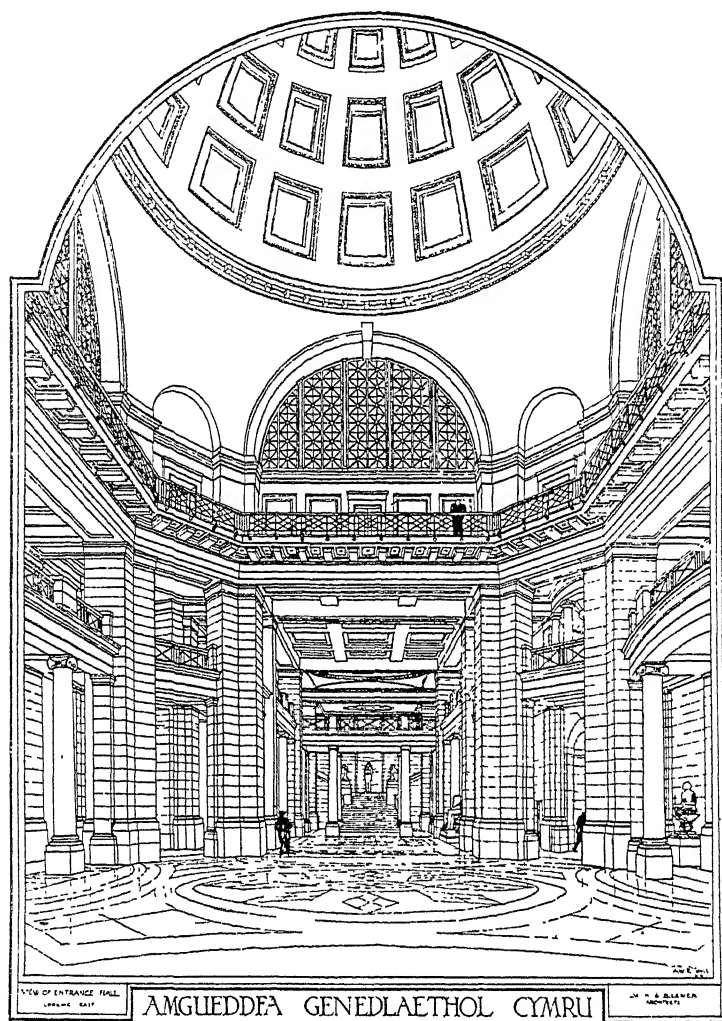


FIG. 2.—Entrance Hall of National Museum of Wales.

Obituary.

PROF. C. S. SARGENT.

FOR more than half a century the name of Prof. Charles Sprague Sargent, Director of the Arnold Arboretum, Harvard University, has been familiar to all who have interested themselves in the scientific cultivation of trees, and we learn with deep regret that he died on Mar. 22 at his home at Brookline, Jamaica Plain, near Boston, Massachusetts.

Prof. Sargent was a descendant of an old Gloucestershire family and he was born at Boston on April 24, 1841. After graduating at Harvard in 1862, he spent three years in the Federal Army, retiring with the rank of brevet major in 1865. He then spent several years in European travel, and afterwards settled down to botanical study at Harvard, devoting his time very largely to the study of the native trees and shrubs of North America. In 1872 he was appointed Director of the Arnold Arboretum, which was at that time in course of formation in connexion with Harvard University. He was connected with that institution until the day of his death, and it was entirely due to his personality, knowledge, energy, and liberality that the Arnold Arboretum attained the proud position it holds in the scientific world to-day.

In addition to forming a very complete collection of trees and shrubs hardy in this particular locality, Prof. Sargent wrote or edited numerous works on trees and shrubs. His "Silva of North America," published between 1891 and 1902, in fourteen quarto volumes, is a monumental work, and will long remain the standard work on North American trees. His connexion with botanical exploration in China and Japan is well known to dendrologists. In 1892 he undertook a prolonged journey in Japan in order to study the native trees, and the result of his observations became known when he published his "Forest Flora of Japan" in 1894. He afterwards took a prominent part in the organisation of several of Mr. E. H. Wilson's journeys of botanical exploration to China, Japan, and other countries, and he edited "Plantæ-Wilsonianæ," an enumeration of the woody plants collected by Wilson in China during his two previous expeditions, which was published in 1913. In addition to purely botanical knowledge Prof. Sargent also possessed a thorough understanding of the cultural requirements of trees and their disposal for landscape effect. He was always ready to impart his knowledge, and was particularly generous in the distribution of plants to other institutions and individuals in his own and foreign countries.

Prof. Sargent was a constant correspondent with the Royal Botanic Gardens, Kew, and was always ready and anxious to share with Kew any of the interesting plants which were collected through the agency of the Arnold Arboretum in China, Japan, or elsewhere. He paid several visits to Great Britain and always spent much of his time at Kew. In addition he paid visits to see all the more interesting specimens of trees and shrubs

which flourish in Great Britain but may not be hardy in the more severe climate of eastern North America. His death is a great loss to botanical science both in America and in Great Britain, where he had many friends.

It is with great regret that we receive the news of the death of the distinguished French man of science, Daniel Berthelot. The son of Marcelin Berthelot, the centenary of whose birth is being celebrated in the present year, Daniel Berthelot showed much of the originality and width of outlook of his illustrious father. After periods of service at the Sorbonne and the Collège de France, he became professor of physics at the École de Pharmacie, and it was in his laboratory at Meudon that he made most of those discoveries and researches in the fields of pyrometry, temperature scales, gas densities, and the chemical effects of ultra-violet light for which his name will be held in remembrance. The famous characteristic equation which he introduced has become second in importance only to that of Van der Waals, and is more accurate than the latter within its legitimate field of application. Daniel Berthelot laid the foundations of accurate gas thermometry and the physical methods of determining molecular and atomic weights which have closely rivalled, if not even excelled, the most accurate procedure of gravimetric analysis. In the field of chemistry his most notable discovery was probably the production of formaldehyde when a mixture of water vapour and carbon dioxide is exposed to ultra-violet light, and of formamide when carbonic oxide and ammonia are similarly irradiated. These syntheses lie at the foundations of biochemistry.

THE issue of the *Physikalische Zeitschrift* for Feb. 1 contains a notice of the life and work of Prof. Des Coudres of Leipzig, who died on Oct. 8, written by his colleague, Prof. W. Wien. Des Coudres was born on Mar. 13, 1862, at Veckerhagen, near Göttingen, of a family which had left the Spanish Netherlands during the religious wars. He was at school at Cassel until 1881 and then studied in succession at Geneva, Leipzig, and Berlin. He took his doctor's degree under Helmholtz at Berlin in 1887 and in 1889 went back to Leipzig as assistant to Wiedemann. In 1897 he was appointed professor of applied electricity there, but in 1901 went to Würzburg as professor of theoretical physics and in 1903 succeeded Boltzmann at Leipzig. He never married, and was content to live for twenty-three years in his rooms in the attic of the Physical Institute. He was fond of travelling, particularly in warm sunny countries. He is probably best known for his work on the speed of cathode rays.

WE regret to announce the death of Dr. S. W. Richardson, formerly principal and professor of physics at University College, Southampton, on April 10, aged fifty-seven years.

News and Views.

IN a paper entitled "Observations upon Mining Law in the Empire," read before the Institution of Mining and Metallurgy on April 21, Mr. Gilbert Stone introduced a subject of vital importance to the mineral industry. Laws and regulations frequently contain provisions that tend to hinder the industry they seek to assist; this may be due to the operation of changed local conditions; it is obvious that regulations suited to a new and undeveloped territory become unsuitable when the region has been occupied by a rapidly growing agricultural community or by large industrial centres. On the other hand, the law may be radically wrong: China, with its great resources, has little mineral development because the law and customary rules—which permit the pursuit of minerals across anybody's land, without compensation or regulation, but only by a special caste, whose members must be bought out—operate to prevent modern methods of development; capital cannot be attracted in such circumstances. That is an extreme case, but cases could be cited from parts of the British Empire of laws that have prevented or seriously hampered either prospecting or development.

WHILE admitting that local differences must be respected in the framing of mineral law, it is clear there is too much diversity in the regulations for prospecting, in the charges for rents and royalties, and in the method of their determination; also in the mode of staking a claim and obtaining a title, and there are still regions where it is uncertain in whom the mineral rights reside. In the British territory in Africa alone, there are twenty-one different codes of mining law. Mr. Stone considers that our mining codes should make matters easier for the pioneer prospector, for a single discovery may alter the whole history of a country in which it is made. In order to encourage the free flow of capital, everything should be done to establish clear and unimpeachable titles, for suitable terms. The short-term lease may be very wasteful of the country's resources. The Advisory Council on Minerals of the Imperial Institute, to which Mr. Stone is legal consultant, is performing a valuable function in assembling for comparative study and analysis the diverse forms of mining law now current.

To enable the manufacturer and the tax-payer to appreciate what the State-aided research associations in Great Britain have achieved in the first few years of their existence, the Department of Scientific and Industrial Research has just published a report on "Co-operative Industrial Research" (London: H.M.S.O. 9d. net), which gives an account of their activities, grouped under results of commercial value and indirect benefits to industry. Another section of the report deals with the measure of support which each association has been given by the industry it serves. Presumably the report is intended to arouse public opinion to the necessity for industrial research,

but it is an uninspiring publication. The information given is scanty in the extreme, the research needs of the industry are never clearly stated, and very few of the problems which are absorbing the attention of the scientific staffs are mentioned. Many of the so-called results recorded cannot be classed as research: they merely serve to display the barrenness of ideas and crudities of practice which characterise many British manufacturing firms. The report states that "many of them [the research associations] have directed their attention to removing defects and avoiding waste: it may be said that there is a general tendency to seek rather to improve the efficiency of existing industrial processes than to devise radically new processes or products." The impression the report is likely to produce on the tax-payer, and even on the manufacturer who knows what real research means, is that the direct and indirect benefits accruing to industry as the result of the activities of the associations have been bought very dearly. The photographs of buildings and laboratories published in the handbook will probably tend to reinforce that impression rather than to remove it.

THIS week is marked by the centenary of the birth of Capt. John H. Speke, African explorer and discoverer of the source of the Nile. Speke was born near Ilchester in Somersetshire on May 4, 1827. Educated for the Indian Army, whilst on service his inclinations were strongly set towards the exploration of central equatorial Africa. After soldiering work in the Crimea, the opportunity came in 1856 of associating himself with Richard Burton in an official expedition to central Africa, the chief objective being the traditional equatorial lakes. On July 9, 1858, Speke himself left the base Kazé, marching north, and on July 30, 1858, after an arduous journey, reached the great expanse of water named by him Victoria Nyanza. His unalterable belief that he had discovered the source of the Nile was contested by Burton. On May 8, 1859, Speke arrived in England. His ardour undiminished, he immediately engaged in preparations for a supplementary expedition, avowedly for the purpose of establishing the truth of his assertion that Lake Victoria Nyanza would eventually prove to be the source of the Nile. In this project for confirmation he had the full support of Sir R. Murchison and the Royal Geographical Society. Speke left Zanzibar in September 1860, accompanied by a fellow explorer, James A. Grant (also born in 1827). The object was ultimately achieved. The point where the Nile leaves the Victoria Nyanza was named Ripon Falls. The fact that the Nile had been traced to its source created a profound sensation when communicated at a meeting of the Royal Geographical Society on May 11, 1863, and Speke's book, "Journal of the Discovery of the Source of the Nile," published in 1863, was widely read. Murchison stated that in discovering the source reservoir of the Nile, Speke had succeeded in solving the "problem of all ages."

SIR CHRISTOPHER WREN and his scientific contemporaries, Elias Ashmole and Dr. Robert Plot, are to be commemorated on Tuesday, May 17, at Oxford, by the unveiling of three armorial windows in the Old Ashmolean Museum by the Chancellor of the University, Viscount Cave. The window to Wren has been appropriately presented by the fellows of the Royal Institute of British Architects, who held a most successful meeting in Wren's Sheldonian Theatre in the summer of 1925, and it is expected that the president of the Institute will attend in person to pronounce an eulogy on his great predecessor. The windows to Ashmole and Plot are presented by the colleges with which they were respectively connected while in residence in Oxford. By the addition of these windows to the window to John Tradescant, described in these columns on Dec. 4 last, not only is a very beautiful decoration being added to the fine staircase of the Old Ashmolean Museum, but also appropriate though tardy recognition is being made to that singular group of seventeenth-century pioneers who by their joint endeavours provided England with her first public museum of natural history. A coloured drawing of the new windows is being issued with the May number of the *Architectural Review*.

WITH reference to the recent notice of the centenary of death of Ernst Chladni, and of his work (*NATURE*, April 2, p. 503), a correspondent writes that the vibrations of metal or glass, which under certain conditions produce the so-called "Chladni's figures," would seem to have engaged the attention of the versatile Robert Hooke when in charge of experiments conducted at Gresham College in the early days of the Royal Society. It is recorded that on Mar. 30, 1671, at the Royal Society, Mr. Hooke produced his glass-bell with flour in it, to show to the eye that, according to the several strokes or pulses made upon the glass, the air thence receives as many impressions; it being manifest by this experiment that as every different stroke made a different sound, so the making a different impression upon the flour gave it as many different motions. It appeared also that the powder goes from the place whence the pulse comes; and that in a perpendicular pulse the powder has a kind of vibration; and also, that so long as the sound of the bell lasts the powder seems to be fluid, but as soon as it ceases the powder also becomes still. It was thought that this experiment might contribute to the understanding of the nature of the internal motion in bodies, and Mr. Hooke was "to prosecute it." On April 27 following, the matter was again referred to at the weekly meeting of the Royal Society, and it was moved that the experiment with the glass-bell and powder should go forward. Hooke does not, however, appear to have met these wishes.

THE art of television is making progress. Mr. J. L. Baird is endeavouring to transmit images of living faces across the Atlantic, and on April 7 the American Telephone and Telegraph Company gave a successful demonstration of television. The president of the company, Mr. Gifford, who was at New York, had a telephone conversation with Secretary Hoover at

Washington. The television apparatus also permitted him to see as well as hear Mr. Hoover. By a special device, also, guests assembled at New York could see the expression of his face as he talked and hear him simultaneously on a loud-speaking telephone. The guests at New York afterwards saw individually by television and talked with the guests at Washington. They also saw the face of a clock shown by a member of the staff at the Bell Telephone Laboratories, Whippany, New Jersey. The experiments prove that under favourable atmospheric conditions it is possible to send images over any distance by television. It is impossible, however, to predict as yet when a cheap and trustworthy system of radio-television will be perfected. An entire scene has to be sent in small individual parts in less than the fifteenth of a second. Only apparatus of extreme sensitivity to light can be used, and the exactness of the synchronisation must not exceed about the hundred-thousandth part of a second. Every one must admire the courage of the inventors who have partially overcome these difficulties.

IN the appeal for membership issued by the National Union of Scientific Workers, which was discussed in a leading article in our issue of Mar. 5, it is categorically stated that the strike is not a possible weapon for such a society, and the possibility of its employment has never been considered by its executive. This statement has led Mr. J. Bertram Ward, in a letter to the Editor, to comment on the possible ways in which the force of numbers is to be applied to effect the principal end the society has in view, the improvement of the economic position of professionally qualified scientific practitioners. Will this force be exerted to control the freedom of action of its members? "Is professional dignity to descend to collective bargaining?" Mr. Ward asks, and "is such bargaining ever more effective than education?" by means of "reasoned yet vigorously insistent propaganda?" Propaganda in this direction, he continues, "is a method which is irresistible and leaves the individual unrestricted." But the fact cannot be ignored that the salaries being offered to scientific workers, even by the State department responsible for scientific and industrial research, are now reduced to a level which must inevitably react adversely on the quality of new entrants to the profession of science. The department would probably welcome any action which would enable it to represent to the Treasury the need for making science an attractive career for the best brains of Great Britain. Scientific workers themselves are in the best position to state what constitutes an attractive career, and they could, if they brought the collective force of a united profession to bear upon individual members, make it practically impossible for employing bodies to impose upon qualified and experienced scientific workers salaries and conditions of employment which would not be tolerated by members of any other profession.

IN connexion with the Smoke Abatement Act which comes into force on July 1, the paper by J. B. C. Kershaw on the relationship between atmospheric impurity and electricity supply, which is published

in *World Power* for April, is of interest. The comparisons made between various towns are naturally only rough approximations, as there are many other factors, for example, the consumption of gas per head, which affect the degree of atmospheric pollution. The results, however, give indications that, as the use of electricity increases, the soot and dust fall per annum diminish in inverse ratio. The official figures show also that the consumption of electricity per head of the population depends very largely on the price charged to the private consumer. There are some notable exceptions to these statements, the explanation of which demands further study. The facts brought out by Mr. Kershaw prove that the data now being collected by the Advisory Committee on Air Pollution will prove of value. Birmingham and London can boast of a degree of atmospheric cleanliness which is satisfactory. The atmospheric pollution in these cities is only double that of a purely residential town like Southport and only one-third that of St. Helens or Burnley.

How rapidly the literature of earthquakes is growing is shown by the issue begun last year of the *Bibliographical Bulletin*, prepared by the Eastern Section of the Seismological Society of America. The *Bulletin* appears quarterly, and the recent issue (for Oct.-Dec. 1926) contains one hundred entries, besides addenda, many of which are accompanied by brief summaries. Copies of papers for notice in future numbers of this useful journal should be sent to the Dominion Observatory, Ottawa, Canada.

THE Air Ministry has published the fourth edition of the "Marine Observers' Handbook" (London: H.M.S.O. 3s. 6d.). The pamphlet has been thoroughly revised and contains, in addition to chapters on the use of instruments, sections on non-instrumental observations, including optical phenomena and hydrographic observations. There are also some useful correction and conversion tables, and a tinted supplement illustrating the chief forms of clouds. Though the publication is mainly intended for marine observers, it would prove of almost equal value at land stations.

THE Report of the Bankfield Museum, Halifax, for the year 1925-26, is apparently the first to be published by the committee, which thus signals the first year of service of Mr. G. R. Carline, who succeeded the late H. Ling Roth on April 1, 1925. Mr. Carline seems to be carrying on the good work with much energy. There were three special exhibitions of art objects during the year. The collection of pottery has been rearranged; the case devoted to native pottery of British Guiana is of particular importance. Room has been made for an extension of exhibits relating to weaving, which is the subject of chief interest to Halifax. Many additions have been made to this series, as well as to the collection of bygonies and objects illustrating local history. The provision of an index to the report is a feature to be commended.

THE *Proceedings of the Indian Association for the Cultivation of Science* are now issued under the title, *Indian Journal of Physics*. Part 2 of Volume 1 con-

tains the report of the Association for the year 1925, presented by the secretary, Prof. C. V. Raman. The cost for the year was about 40,000 rupees, towards which the Indian Government contributed 10,000 rupees. Considerable additions have been made to the library, the laboratory apparatus, and the workshop, and during the year fifteen research workers from various parts of India carried out investigations in the laboratory on the scattering of light, the acoustics of the violin, the magnetic susceptibilities of gases, and the properties of surface films. More than twenty papers have been published during the year, four in the *Proceedings of the Royal Society of London*, three in the *Philosophical Magazine*, and the remainder in other scientific journals.

NUMBER 75 of the *Miscellaneous Publications* of the Bureau of Standards, Washington, consists of the annual report of the Director, Dr. G. K. Burgess, for the fiscal year ending June 1926. The total expenses were nearly 2 million dollars, of which 516,000 dollars represent salaries, 232,000 dollars tests of structural materials, 174,000 dollars industrial research, 111,000 dollars standardisation of the products of industry, 100,000 dollars investigations of public utility services and conditions, 70,000 dollars equipment, and 54,000 dollars investigations for the Navy and for aviation. Close contact with the industries of the country is maintained by means of advisory committees composed of technical representatives from the industries and by the research associates appointed by the industries to carry out researches at the Bureau. A visiting committee reports once a year to the Secretary of Commerce on the efficiency of the Bureau. Some of the reductions effected on economical grounds in the varieties of articles of the same description produced by manufacturers are remarkable, e.g. files and rasps, from 1351 to 496; sheet steel, from 1819 to 263; concrete blocks, tiles, and bricks, from 115 to 24.

AN Illustrated Guide to the Singapore Botanic Gardens has just been published. These Gardens are among the finest of tropical botanic gardens, and as the last guide (issued 1889) has been out of print for some years, the new issue has been long overdue and supplies a much-needed desideratum for botanists and general visitors. In recent years alterations of considerable magnitude have been carried out; and while due attention has been paid to scientific considerations in laying out the gardens, the scenic and landscape aspects have not been neglected. Here most species of the Indo-Malayan flora as well as other forms have been brought together and skilfully arranged. Some species are grouped on conventional garden lines, and others are assembled in a kind of natural jungle. In the Guide the vegetation is described section by section of the Garden, with interesting notes on large numbers of the species. The work is profusely illustrated with photographs of the more striking scenes and species, while an index of species and a good map of the Gardens complete the book.

THE "Report on the Health of the Army for the Year 1925" (vol. 61) (London: H.M.S.O. 3s. 6d. net) has recently been issued, fourteen months after

its predecessor, and it is hoped that the report for 1926 will be published still more quickly. The report is arranged by Lieut.-General Sir Matthew Fell, Director-General of Army Medical Services, on the same lines as those for the two preceding years. Throughout the year the health of the troops at home and abroad was satisfactory, and the incidence of sickness shows an improvement on that of the preceding year. Malaria accounts for the largest number of admissions to hospital, and tonsillitis comes third on the list. Only 218 cases of enteric fever occurred in the whole army, of which 184 cases were in India. Inflammation of the middle ear (449 cases) again takes first place as a cause of invaliding out of the army.

THE danger to man of the bites of certain spiders seems, after many years of uncertainty, now to be established beyond doubt. Following the description of arachnidism as a definite clinical entity by Dr. Bogen of Los Angeles (NATURE, Dec. 25, 1926, p. 927), the death of a child from a spider's bite has been reported from Sydney (*Sydney Morning Herald*, Feb. 24, 1927). The spider responsible, produced at the inquest, was identified as *Euctimena tibialis* Rainbow, a rare trap-door or mygalomorph spider. The scientific interest of this lies in the fact that hitherto all the authenticated and most of the suspected cases of poisoning by spiders have been attributed to the genus *Latrodectus*, of the family Theridiidae, whereas *Euctimena* is a member not only of a different family but also of another sub-order of spiders.

Most countries are now undertaking organised research on the causation, prevention, and cure of cancer, and the University of Sydney has issued a pamphlet on its cancer research and treatment organisation (The Australian Medical Publishing Co., Sydney). A fund of £130,000 has been collected from various sources. Three main lines of research have been developed during the last three years: *bio-physical*, for which a special laboratory has been equipped; *bio-chemical*, and *biological and pathological*, which are being pursued in the University and Hospital departments. It is also proposed to establish a radium institute for treatment.

WE have received the annual report for the year ended July 31, 1926, of the National Institute for Research in Dairying, which now forms a constituent part of the University of Reading. The Report summarises the work of the various departments, the condition of the farm and farm buildings, the publications issued, and the financial needs of the Institute. As regards the last named, £30,000 is required for adapting the Shinfield Manor estate which has been acquired for the work of the Institute, towards which £20,408 has so far been collected by grants, donations, and subscriptions.

THE International Commission on Illumination will hold a short session at Bellagio on Aug. 31-Sept. 3. A plenary session of the Commission should take place in New York this year, but for various reasons it has had to be postponed until 1928. The session at

Bellagio is solely one for the executive committee and the various sub-committees appointed by the Commission to study such problems as factory and school lighting, automobile headlights, heterochromatic photometry, definitions and nomenclature, and colorimetry. It is hoped that the meetings of the sub-committees will do much to facilitate their work and lead to a successful meeting next year, besides enabling the countries which have recently joined the Commission to become acquainted with its work. The meeting at Bellagio will be under the presidency of Dr. E. P. Hyde, and the arrangements are being carried out by the Italian National Committee on Illumination.

AT the anniversary meeting of the Linnean Society to be held on May 24 next, the following medals will be awarded: The Linnean Medal in gold, given each year to an eminent biologist as an expression of the Society's estimate of his services to science, usually to a botanist and a zoologist in alternation, will be presented to Dr. Otto Stapf. Dr. Stapf has served as Keeper of the Herbarium at Kew, and is now the editor of the *Botanical Magazine*. The Crisp Award was established by a donation of £200 by the late Sir Frank Crisp, for the best paper dealing with microscopical research by a fellow of the Society since the last award, and is made at intervals of five years, accompanied by a medal in bronze and the balance of the income of the principal. The recipient this year will be Prof. Herbert Graham Cannon, professor of zoology in the University of Sheffield, for a paper on the "Post-Embryonic Development of the Fairy Shrimp (*Chirocephalus diaphanus*)," issued last year in the zoological journal of the Society.

THE nineteenth meeting of the Australasian Association for the Advancement of Science will be held in Hobart, Tasmania, during the week commencing Jan. 16, 1928. The president-elect is Mr. R. H. Cambage. The following presidents of sections have been elected: Section B (Chemistry), Prof. H. G. Denham, Canterbury College, Christchurch, N.Z.; Section C (Geology and Geography), Prof. L. A. Cotton, University of Sydney; Section D (Zoology), Dr. Colin Mackenzie, Director of the National Museum of Australian Zoology, Melbourne; Section E (History), Mr. T. Dunbabin; Section F (Anthropology), Dr. R. H. Pulleine; Section G (Social and Economic Science and Statistics), Prof. R. C. Mills, University of Sydney; Section H (Engineering and Architecture), Mr. Alan C. Walker; Section I (Medical Science and National Health), Dr. J. H. L. Cumpston; Section J (Education, Psychology, and Philosophy), Mr. M. P. Hansen; Section K (Agriculture and Forestry), Prof. A. J. Perkins, Director of Agriculture, South Australia; Section L (Veterinary Science), Mr. Max Henry; Section M (Botany), Prof. T. G. B. Osborn, University of Adelaide; Section N (Physiology and Experimental Biology), Prof. H. G. Chapman, University of Sydney; Section O (Pharmaceutical Science), Mr. Edward Mayhew. The honorary general secretary of the Australasian Association is Dr. A. B. Walkom, Royal Society's House, 5 Elizabeth Street, Sydney, and the honorary

secretary for the Hobart meeting, Mr. Clive Lord, Director of the Tasmanian Museum, Hobart.

A USEFUL and interesting catalogue (No. 284) of second-hand books, and publications of learned societies has just been issued by W. Heffer and Sons, Ltd., 4 Petty Cury, Cambridge. The list comprises upwards of 2000 volumes and is classified as follows: Agriculture, husbandry, and farriery; botany; chemistry, chemical technology, and metallurgy; geology, mineralogy, and palæontology; zoology and biology; anthropology and ethnology; and mathematics, physics, astronomy, and engineering. Included are a number of works from the library of the late Prof. A. Dendy.

IN the list of forthcoming books of the Oxford University Press which has just reached us we notice the following:—"Stars and Atoms," Prof. A. S. Eddington. "Conditioned Reflexes of the Cerebral Hemispheres," Prof. I. Pavlov; translated under the supervision of Dr. G. Anrep. "Chemistry," W. H. Barrett. "Animal Biology," Prof. J. S. Huxley and J. B. S. Haldane. "How a Tree Grows," Prof. W. Somerville. "The Flora of Oxfordshire," Dr. George Claridge Druce; second edition. "Oxford Forestry Memoirs," No. 7: "The Gold Coast Forest—A Study in Synecology," Major T. F. Chipp. "Grass Land: Its Management and Improvement," R. G. Stapledon and J. A. Hanley. "The Conquest of the Air," C. L. M. Brown. "A Bird Book for the Pocket," E. Sanders. "Advanced Constructive Geometry," J. F. Dowsett. "Mathematics for Students of Technology": Senior Course, L. B. Benny. "Elements of Mining Science," D. E. Thomas. "A B C of Plastering," A. H. Telling. "Elementary Building Science," A. Everett. "Industrial Electric Motors," W. Wilson. "Essays in Ægean Archæology." Papers presented to Sir Arthur Evans. "The Corridors of Time," H. Peake and Prof. H. J. Fleure. 1. "Apes and Men"; 2. "Hunters and Artists"; 3. "Peasants and Potters";

4. "Priests and Kings." "Environment and Race": a study of the evolution, migration, settlement, and status of the races of man, Dr. T. Griffith Taylor. "Kingship," A. M. Hocart.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in economics in the University of Sheffield—The Registrar (May 12). A university lecturer in mathematics in the University of Cambridge—Prof. A. S. Eddington, the Observatory, Cambridge (May 14). A principal of the Municipal School of Science, Technology, Commerce, etc., Bournemouth—The Director of Education, Town Hall, Bournemouth (May 14). A junior scientific officer on the Air Ministry Scientific Research Staff, for research in connexion with electrical appliances, with special reference to electrical ignition apparatus—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (May 18, quoting A.157). Junior technical officers for the Wireless Experimental department of the Royal Aircraft Establishment—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (May 21, quoting A.160). A lecturer in veterinary pathology bacteriology and protozoology in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (June 18). A professor of organic chemistry at the Indian Institute of Science, Bangalore—Dr. M. O. Forster, c/o Messrs. Jeremiah Lyon and Co., 4 Corbet Court, E.C. 3 (June 29). A laboratory assistant, with experience of section cutting and general pathological and bacteriological work, at the Lincoln County Hospital—The Secretary-Superintendent, County Hospital, Lincoln. A graduate in engineering to take mechanical engineering subjects at the Dartford Technical College—The Principal, Technical College, Dartford. Research chemists in the research laboratories of Boots Pure Drug Co., Ltd.—Boots Pure Drug Co., Ltd., Chief Research Chemists, Station Street, Nottingham.

Our Astronomical Column.

COMETS.—Four comets are likely to be fairly easy telescopic objects during May. Ephemerides of these, for 0^h U.T., are given below:

			R.A.	N. Decl.	log r.	log Δ.
Comet 1926 <i>f</i> , Comas Sola.	Apr. 30.	6 ^h 48 ^m 26 ^s	33° 2'	0 2626	0.3468	
	May 8.	7 12 32	32 37	0 2876	0.3602	
	16.	7 36 20	31 57	0 2730	0.3741	
	24.	7 59 32	31 4	0 2790	0.3874	
1927 <i>c</i> , Pons- Winnecke.	Apr. 30.	14 57 16	48 13	0 0999	9.6286	
	8.	15 1 18	50 33	...	9.5704	
	16.	15 5 30	52 30	0.0615	9.5041	
	24.	15 14 30	53 55	...	9.4206	
1927 <i>d</i> , Stearns.	Apr. 29.	14 42 20	10 37	0 5683	0.4417	
	May 7.	14 34 31	13 18	0 5692	0.4473	
	15.	14 26 55	15 42	0.5703	0.4564	
	23.	14 19 52	17 47	0.5715	0.4683	
1927 <i>e</i> , Grigg- Skjellerup.	Apr. 30.	6 46 25	9 16	9.9571	9.6025	
	May 4.	6 57 4	12 13	9.9531	9.5650	
	8.	7 8 58	15 45	9.9510	9.5248	
	12.	7 22 20	20 3	9.9509	9.4822	
	16.	7 38 28	25 16	9.9527	9.4385	
	20.	7 58 5	31 33	9.9551	9.3957	

Popular Astronomy for April contains a photograph of 1927 d taken by Prof. G. Van Biesbroeck on Mar. 13. There was a large conspicuous coma, and a faint tail 10' long in P.A. 215°. The nucleus was of about mag. 11, and was photographed with 20 sec. exposure.

* This comet has the fourth greatest perihelion distance known, 3.68 units; those exceeding it are 1925 a, 4.18 units; 1729, 4.06 units; 1914 III., 3.75 units.

The *Melbourne Age* for Feb. 18 contains the interesting announcement that Mr. Z. A. Merfield proposes to use the great Melbourne reflector for spectroscopic observations of the comet Pons-Winnecke. He is the son of Mr. C. J. Merfield, assistant at Melbourne Observatory, and obtained very successful photographs in Sumatra of the solar eclipse of January 1926. His spectrograph is being mounted on the reflector, which has been out of use for forty years. The comet goes south very rapidly after its perihelion passage on June 21, so it will then be very favourably placed for southern observers.

Prof. G. Van Biesbroeck followed comets 1926 e (Giacobini-Zinner), 1925 a (Shajn-Comas Sola), 1926 g (Neujmin) up to the first week in March; they had been under observation for five months, two years, and four months respectively. He noted that 1926 g had been of mag. 12 early in February, but after that it faded rapidly. 1925 a had sunk to mag. 16 and it was impossible to follow it for longer.

Research Items.

PRE-SUMERIAN MAN IN ARABIA.—On their return from Kish through the desert lying between Mesopotamia and Palestine in the winter of 1925–26, Mr. L. H. Dudley Buxton and Mr. Henry Field devoted to a search for evidence of the existence of early man in this area such time as was available during the halts of the armoured-car patrol which they accompanied by permission of the Air Marshal. In *Discovery* for April, the former describes the journey and the circumstances in which quite a considerable number of flint implements were found at each stage of the journey. It is interesting to note that the Arab desert police denied the use of flint for any purpose other than strike-a-lights, thus authenticating certain flakes of a somewhat modern appearance. Evidence the most definite in character was obtained at Landing Ground R, a number of implements of Aurignacian type being found. Near Air Force Landing Ground H was found a large lake of perhaps a hundred acres in extent but of not more than a foot deep. On the lower of two surfaces exposed in ancient times, a large number of small tools were found, the other surface showing no evidence of man's handiwork. The implements found on the journey as a whole belong to the middle and late palæolithic age, with one laurel-leaf arrow-head belonging probably to the new stone age. Although the desert conditions are not now such as to support human life, the fact that the implements are found in hollows and little dry valleys suggests that under different climatic conditions, such as probably prevailed in palæolithic times, water flowed down the valley bottoms. This upland divide thus furnishes evidence of man's existence at a period long anterior to that of the material from Mesopotamia itself, where nothing primitive but only the remains of a fairly advanced culture have as yet been found.

SHILLUK BEGGING CUSTOMS.—Among some notes on the customs of the Shilluk, contributed to *Sudan Notes and Records*, vol. 9, No. 1, by the Rev. D. S. Oyler, is an account of begging customs observed especially by women, who seem to derive much pleasure in begging cattle from the richer men of the tribe. The occasion is observed as a holiday for the women of the village, all of whom take part unless there should be too many, when only the women of a certain age go. Women from two villages never unite on these expeditions. The proper time for the begging dances is just before the rains, though they may be held at any time during the dry season. The man from whom the women are to beg is selected before the expedition starts. It is regarded as an honour. As a rule the man selected is not one of their own village, but should he be, the women ask for a sheep only. Although the women usually object to leaving their babies, on these occasions they leave them at home in charge of the men. Before starting a leader is chosen, known as a *bana*, who has the power of a magistrate, is crowned as a village chief is crowned, and deals with any trouble among the women. She acts as chief in any expedition made later by the same party; and in the village she has the right to judge in any dispute strictly between women. In the event of a refusal of an ox, a man's wife may intercede for the visitors, dancing among them; but if the owner persists in his refusal, the party departs cursing him and his family. Any sickness which follows is attributed to this curse, which can only be removed by the return of the party, the gift of an ox, and a petition by the women for the removal of the curse,

accompanied by the sprinkling of ashes. A similar custom prevails at the time of threshing corn, when the women sit in silence around the threshing floor holding out their gourds, into which corn is placed when the threshing is finished.

THE SPECIES AND SEX-RATIOS OF *RAIA*.—Augusta Lamont has recorded (*Proc. R. Phys. Soc. Edin.*, 21, pp. 73–82, 1926) the relative frequency of the species of the genus *Raia* (the skate) and the sex-ratios of 1714 specimens delivered to the Department of Zoology, University of Edinburgh, for class purposes during the years 1920–1925. These fish were probably for the most part caught in the Firth of Forth or in the neighbouring part of the North Sea. Five species were represented—*Raia radiata* 1069, *R. circularis* 381, *R. batis* 227, *R. clavata* 19, and *R. fullonica* 18. The author points out that to some extent artificial selection, e.g. of specimens of convenient size for laboratory work, may have operated to bring about a modification in the relative numbers, so that the proportions are not necessarily indicative of the natural frequency, though they are not markedly at variance with the observations of Day. *R. radiata* was the commonest species from October to May, reaching a maximum in February and March; *R. circularis* was the most frequent species in July but was scarce in the winter and spring. The observations on the sexes cover only four years, and for the five species taken together there were 757 males and 727 females. During the first three years *R. radiata* was represented by 347 males and 310 females, but in the fourth year the respective numbers were 102 and 154, a striking reversal of the previously existing ratio.

THE EGGS AND YOUNG OF HALOBATES.—Dr. H. C. Delsman has had exceptional opportunities for studying this interesting marine insect, the habits and young of which he describes in a recent paper ("On the Propagation of Halobates," *Treubia*, vol. 8, Livr. 3–4, 1926). During his cruises with the investigation-steamer *Brak* over the Java Sea and along the east coast of Sumatra, the eggs and adults were frequently found. The author is emphatic in stating, contrary to the opinion of other observers, that Halobates cannot dive, and that, if forced under water, it dies after making futile swimming movements in attempting to regain the surface. He distinguished five different sorts of eggs, all attached by a glue-like substance to various floating objects such as seaweeds, Spirula and Sepia shells, and birds' feathers; also coal slag, wood, or cork. Sometimes thousands of eggs were found on one object, and this must have been the result of the egg-laying of many individuals, as no more than twenty-five eggs have been found inside one female. Clear figures are given of the embryo in its various stages. Directly the larva hatches it moults, leaving its skin behind attached to the egg membrane, and the young Halobates move to the surface, adopting at once the mode of life of the adult, its form scarcely differing at all from that of the adult. These are valuable notes on the life-history of members of a little-known group.

A TACHINID PARASITE OF THE LARVÆ OF COCONUT MOTHS.—The larvæ of certain moths of the family Zygaenidæ are serious enemies of the coconut, and in the *Malayan Agricultural Journal* for Oct. 1926, Mr. B. A. R. Gater contributes some observations on the life-history of the Malaysian coconut moth

(*Artona catoxantha*). It appears that the larvæ of this insect are parasitised by a tachinid fly, *Ptychomyia remota*. The latter beneficial insect, however, suffers from parasites of its own, which militate to a considerable extent against its utility as a natural controlling agent. In a second paper Mr. Gater gives further details concerning the biology of this tachinid. Its liability to the attacks of hyperparasites is further dilated upon; but in spite of their activities the insect is capable of destroying 30 per cent. to 40 per cent. of its host, and in most cases exceeds that figure. Inquiries were received from Fiji with respect to the possibility of importing into those islands parasites of the *Artona* moth with the object of testing their effects on an allied zygenid *Levuana iridescens*. The latter insect is an important pest of coconut in Fiji, and the need for attempting its control was urgent. After considerable difficulty, some 300 adult examples of the *Ptychomyia* reached Suva alive, and it was found that they parasitised the *Levuana* larvæ as readily as those of their Malayan host. The tachinid has proved its value, and is reported as destroying at times up to 90 per cent. of the *Levuana* larvæ. It is now well established in Fiji, where its greater efficiency is probably due to its freedom from the hyperparasites that are so prevalent in the Malay States.

GENETICS OF DORMANT MAIZE.—Genetical investigations at the Connecticut Agricultural Experiment Station (Report 49) have shown that the mature and completely developed dormant maize seed is the outcome of a number of processes in which the cumulative action of at least 27 Mendelian factors is essential, and suggest that further work will probably reveal the necessity for several more. Defective seeds may be hereditary or non-hereditary. In the former case the condition frequently arises by mutation in homozygous inbred strains; it is estimated on an average that one plant in every thirty is heterozygous for defective seeds. Fertilisation occurs in these cases, but the development of embryo and endosperm fails or is rudimentary only. Non-hereditary defectives fall into four classes according to the cause of their abnormal condition. *Parthenocarpic* defectives arise from failure of the pollen tube to reach the micropyle, and consequently neither embryo nor endosperm is formed. The age of the silks and pollen, and probably also environmental conditions, influence the production of this type of seed. *Arrested* seeds, however, contain both embryo and endosperm, but owing to competition of physiological dominance of the adjacent normal seeds, their development is retarded. *Germless* seeds result from a single instead of a double fertilisation and lack an embryo, while *miniature* defectives, though normal in form, are reduced in size, due possibly to an abnormal number of chromosomes in the endosperm. Altogether thirteen factors have been found which may cause the formation of defective seeds, and five additional factors which in affecting the endosperm may also prevent normal seed development. On the other hand, nine factors have been found which induce premature germination by inhibiting dormancy and are therefore as fatal to the seed as the retarding factors. Since the hereditary units involved in the short period of the plant's life between fertilisation and the resting stage of the embryo are apparently so complex, knowledge of those concerned with the ontogeny of the entire plant is clearly of a rudimentary nature only.

PALEONTOLOGY IN SOUTH AFRICA.—Last year, for the first time in the history of the Geological Society of South Africa, the presidential chair was occupied

by a palæontologist. The anniversary address by Dr. S. H. Haughton was therefore of exceptional interest, since it passed in review the leading facts of present knowledge with regard to animal remains in South Africa, their relation to similar faunas from other regions, and the many problems that still await further discoveries for their solution. Of 186 marine species from the Bokkeveld Beds, 40 are common to South America and 71 are varieties of, or are closely allied to, South American forms. The fauna contains an almost negligible European element, suggesting that it flourished along the shores of the Devonian land area that has been called Falklandia. The South African Permian fauna is found in Russia and Scotland, but is absent from central Europe. The conclusion is reached that there was no passage across the Tethys by the Iberian land-bridge, but that migration occurred by way of Syria to Persia or the Caucasus and thence north-westwards. It is pointed out that much more work is necessary to determine the geographical changes that have taken place since the Cretaceous, and an appeal is made to the universities and museums to stimulate and encourage further interest in the study of palæontology, which hitherto in South Africa has been regarded as little more than a subsidiary adjunct to geology.

OIL CONTAMINATION AS A CLIMATIC FACTOR.—Mr. L. A. Ramdas, of the Meteorological Office, Karachi, in a letter to the Editor, makes the novel suggestion that the oil which is now being discharged into the sea in appreciable quantities, especially by the wreck of oil-bearing ships, may have a measurable effect on the total rainfall of the globe. It is well known that oil on a water surface spreads out into a very thin film, and it is natural to expect this film to interfere with the free evaporation of the water, a result which has been confirmed by experiment. A decrease of evaporation from the oceans would result in a general decrease of rainfall over the globe. Mr. Ramdas tested this by comparing the mean annual rainfall at 142 stations for the two periods 1880–1900 and 1900–1920, and he found that the mean of the second period was less than that of the first by about one per cent. over the earth as a whole and four per cent. over the tropics. He recognises that this result is not conclusive, but hopes to obtain further evidence, especially by examining the rainfall of individual years in relation to the number of wrecks of oil-bearing ships.

AN ANCIENT THEODOLITE.—The theodolite in its simplest form is due to Leonard Digges of University College, Oxford (about 1550), and was first described in 1571 under the name of the 'Topographical Instrument.' An example of this instrument made by Humphrey Cole in 1586, with the improvements of the theodolite of Bleau of a later date, was discovered in St. John's College library and is now in the Lewis Evans collection of scientific instruments. A reprint of Digges' description in his "Pantometria" of 1571 has been published with a short preface by Dr. R. T. Gunther (Old Ashmolean Reprints No. IV. Oxford: 3s.). It consists of seven chapters of Longimetra, which with Planimetra and Stereometra formed the three books of "Pantometria." Copies of the original diagrams and plates are given in the reprint.

MICA.—With the growth of electrical and allied industries, the supply of mica has become a matter of great importance. Its perfect cleavage, transparency, and lack of colour when in thin sheets; its flexibility, toughness, and non-conductivity of heat and elec-

tricity; its resistance to high temperatures, sudden changes of temperature, and to chemical decomposition, constitute an assemblage of properties possessed by no other single mineral and by no artificial products. The mica of commerce is restricted almost entirely to the varieties *muscovite*, potash mica, and *phlogopite*, magnesian mica. Slight differences in the physical properties of these micas give rise to forms particularly suited for special purposes. Thus the Indian ruby mica is the best for condensers; the hard green Carolina mica is the most satisfactory for use in stove fronts and furnace peep-holes; whilst, on account of its extreme flatness, the brown mica of certain parts of Georgia makes the finest gramophone diaphragms. What is known as 'silver amber,' an altered form of phlogopite, is, on account of its softness, employed between the commutator segments of D.C. motors and dynamos. In a short paper on "Mica and its International Relationships," recently presented to the Institution of Mining and Metallurgy, Mr. G. V. Hobson has condensed an extraordinary amount of information on the production, distribution, and marketing of this mineral, leading up to a consideration of the international aspects of the industry, a subject of vital importance in war and becoming one of scarcely less significance in times of peace.

THE SUPPORT OF COAL WORKINGS.—The sub-committee appointed to investigate methods of reducing the number of accidents due to falls of ground in the coal-mines of Great Britain has issued three reports—Papers Nos. 6, 12, and 30—of which the latter is now before us (Safety in Mines Research Board: The Support of Underground Workings in the East Midland Coalfield, Yorkshire, Derbyshire, excluding South Derbyshire, and Nottinghamshire. London: H.M.S.O.; 2d.). The committee is commencing by studying the methods of support used in the different coalfields of Great Britain and pointing out any features which they consider might be more generally adopted with advantage. Perhaps the most important recommendation in the present report is that which refers to the tubular steel prop largely adopted by the Butterley Company, Limited. It consists of a steel tube closed at the top, over which passes a sliding sleeve which can be kept in position by a bolt passing through a slot in the sleeve, whilst the upper part of the sleeve carries a wooden plug. When weight comes on, the wooden plug is crushed in the sleeve, which then slides over the tube, the length of slide which the construction admits of being about 6 inches. The prop can, of course, be used over again by inserting a fresh wooden plug. It is stated that where it is in use only one reportable accident, and that not fatal, due to a fall of roof, has occurred during more than a million man-shifts since the prop was introduced more than eight years ago. It is claimed that this prop keeps the roof in better condition, that it maintains roof height better than wooden props, occupies less space, is more durable, more economical, and easier to withdraw. The report emphasises the need of strict supervision and good discipline, and regrets that relatively little is being done in the matter of safety instruction. Finally, a set of model timbering rules is suggested. The modest price at which this paper is published is intended to bring it within the reach of all, and it is to be hoped that coal miners will take advantage of the information thus placed at their disposal.

CONDUCTION OF ELECTRICITY THROUGH GASES.—Prof. Seeliger's recent article in the *Zeitschrift für Physik* (41, p. 535, 1927) illustrates how little is

actually known about what takes place in a discharge-tube. His own intensity rule, for example, that the higher the energy required to excite a given line of the spectrum of the contained gas, the nearer does the region where its brightness is a maximum approach the cathode, still awaits an adequate explanation, in spite of its apparent simplicity. The number of electrons which leave the cathode for each positive ion received is uncertain, as well as the mode of conduction across the cathode dark space, and exactly how this is affected when the cathode is raised in temperature in order to lower the cathode fall of potential. It seems likewise impossible at present to reconcile the sharp cathode boundary of the negative glow formed in most cases, with the apparent continuity of the latter and the cathode dark space in pure inert gases. Prof. Seeliger is specially concerned with the origin of the visible radiation, which may be produced either as a result of the recombination of ions, or in the return to their normal state of neutral molecules excited by electron impact. Some conclusions can be drawn about the relative importance of the two processes in different parts of a tube, but even then difficulties arise from our meagre knowledge both of the relative numbers of free electrons and negatively charged molecules which are present, and of the nature of the radiation which results from recombination. Unfortunately, there is no immediate prospect of solution of most of these problems.

MAGNESIUM-COPPER ALLOYS.—A paper on "Magnesium-Copper Alloys rich in Magnesium" was read by Dr. M. Hansen at the recent meeting of the Institution of Metals. It is shown that magnesium is capable of holding copper in solid solution to the extent of about 0.1 per cent. at room temperature and about 0.4-0.5 per cent. at 485° C. It has not, however, been possible to detect any preceptible age-hardening in alloys quenched from 450° C. on standing at room temperatures. This appears to be due to the fact that, even on quenching, the compound is precipitated as microscopical particles, which coagulate as the rate of cooling becomes slower. This coagulation is accompanied by a slight decrease of hardness and a considerable increase of ductility. Ageing at high temperature results in no perceptible change in hardness.

COAL CARBONISATION RETORTS.—The Department of Scientific and Industrial Research has issued Fuel Research Technical Paper No. 17 (H.M.S.O., 6d. net) on "Low Temperature Carbonisation." It is of the nature of an interim report on the behaviour of vertical retorts erected at H.M. Fuel Research Station, Greenwich. These retorts are based in design on Scottish shale practice and are of grey cast iron, externally heated to 625° C. in a setting of very simple construction. They are 21 ft. high, of width tapering from 7 m. at the top to 11 in. at the bottom, and provided with mechanical extraction gear. The coal dispute of 1926 restricted the supplies and choice of coal, but results are given for tests on nine different samples. Non-caking nuts were the easiest to work, and gave the highest yield of tar and the greatest throughput. Caking coals received a preheating treatment which reduced trouble due to sticking. Fine coal was dealt with by briquetting. The 'E' retorts, which have been most successful, have been in use for the twelve months ending Dec. 27, 1926, for the carbonisation of 1350 tons of coal, and were then still fit for further service. With the collaboration of the Cast Iron Research Association, a new retort of special metal is under construction and will be tested alongside those referred to above.

Water Vapour in the Atmosphere.¹

THE CONSTITUTION OF FOG AND CLOUD.

THE water in the atmosphere is responsible for practically all the variations which are classed as weather. The way in which it enters the atmosphere, the forms in which it is made visible, and the manner in which precipitation, whereby it leaves the atmosphere, is produced, must always be matters of fundamental importance to meteorology and matters which lend themselves most readily to methods of physical research.

The fact that water drops can be cooled below freezing point without solidifying, and that super-cooled water drops can exist in the atmosphere, was demonstrated long ago by physicists like Jamin and by meteorologists like Assman. That, however, is not the end of the story, and Dr. Kohler has made full use of the opportunities which his position as director of the Halde Observatory provided, to investigate the matter further. This observatory is situated in the extreme north of Norway, at a height of about 3000 ft. above sea-level, and it experiences in the course of the year the full range of variation of temperature, wind, and weather. The results of researches made there in 1920-23 are published in a collected form in the memoir under notice.

The problem was attacked in two ways :

- (1) By microscopic examination of the deposit from fog (or cloud) below freezing point ;
- (2) By an examination of coronæ sometimes round the sun or moon, but more frequently round an artificial source of light placed on the highest point of the Observatory and observed from a distance of about 70 yards.

From microscopic examination it was found that even down to temperatures of -28°C. , the drops in fog were spherical drops and not crystalline in form. Crystals which fell through the fog invariably had upon them numerous spherical drops which they had picked up in their passage. Though crystals might form on wires and plates exposed to the fog, they also invariably had spherical drops on them, and if the exposures were short enough, the first deposits were practically invariably drops and not crystals.

The observations of coronæ are divided broadly into three sections :

- (1) Observations in fog at a temperature definitely above freezing point.
- (2) Observations in fog at a temperature definitely below freezing point.
- (3) Observations in clouds the temperature of which was not directly observed.

There are simple relations connecting the angular radii of the different rings of a corona formed by spherical drops, with the radius r of the drops themselves. They are :

$$\sin \theta_1 = \frac{1.220 \lambda}{2r},$$

$$\sin \theta_2 = \frac{2.233 \lambda}{2r},$$

where λ is the wave-length of the light used. If the corona were formed by long thin crystals instead of by spherical drops, the formulæ connecting the thick-

ness b of the crystal with the angular radii of the rings would be different :

$$\text{namely : } \sin \theta'_1 = \frac{\lambda}{2b}, \quad \sin \theta'_2 = \frac{2\lambda}{2b},$$

$$\text{hence } \frac{\sin \theta'_1}{\sin \theta'_2} = \frac{1}{2},$$

$$\text{while } \frac{\sin \theta_1}{\sin \theta_2} = \frac{1.22}{2.33}.$$

Measurements of θ_1, θ_2 therefore furnish a criterion for distinguishing between coronæ formed by drops and coronæ formed by crystals.

Dr. Kohler found from his measurements that the coronæ in fog were always caused by drops and not by crystals. One or two measurements appeared to be exceptions to the general rule, but these proved on closer examination to be due to special circumstances, such as rain falling at the time of measurement. Observations of coronæ in clouds of the cumulus, alto-cumulus, and strato-cumulus type showed that these clouds also consisted of drops and not crystals, at least on those occasions when they caused coronæ. Observations of coronæ in cirrus and alto-stratus cloud pointed, however, to a crystalline origin. Apart from the evidence of the relative magnitudes of θ_1, θ_2 , it appeared that if the coronæ had been caused by drops, the drops must have been unusually and improbably large, considerably larger than the drops in fog at the level of the Observatory. Coronæ formed by these clouds appear, therefore, to be caused by ice crystals, a deduction supported by the fact that aviators find clouds of the alto-stratus type full of ice crystals, though they do not consist entirely of ice crystals. Some years ago, however, Dr. Simpson, in discussing observations of coronæ in the Antarctic, gave reasons for supposing that ice crystals in the atmosphere could not cause coronæ, and in a later section of his paper, Dr. Kohler runs away from the first and obvious deduction from his measurements and leans to the conclusion that in the alto-stratus and cirro-stratus clouds, the coronæ are caused by drops mixed with crystals. His reasons for rejecting the crystal hypothesis do not appear to be entirely conclusive, and the question whether coronæ are caused in some cases by crystals is still an open one.

Dr. Kohler found drops of different sizes in fogs ; a fog causing coronæ did appear to be constituted for the moment of drops of similar size, but as the diameters of the coronæ changed it was evident that the radii of the drops also changed. When the results of some thousands of measurements were arranged according to the frequency of occurrence of drops of different sizes, the frequency distribution was not, as one might have expected *a priori*, according to the normal curve of errors, but maxima and minima occurred at those values which the radii of the drops would have if drops were made by the combination of two, four, eight, sixteen, etc., primal drops. If m were the mass of the primal drop, then the other drops had masses $2m, 4m, 8m, 16m$, etc. Many years ago, Defant published some observations of the sizes of rain drops which pointed to a similar law, but the sizes of Defant's rain drops were 10-100 times the size of the drops in Dr. Kohler's fogs. It is difficult to see why an original set of drops of uniform size should be produced, but if a layer of such primal drops were formed and these primal drops began to combine by two's, the resulting drops would fall through the atmosphere at a different rate

¹ "Untersuchungen über die Elemente des Nebels und der Wolken." (Stockholm : Hilding Kohler, 1925.)

from the primal drops. These combined drops would therefore have a bigger chance of meeting one another than of meeting a primal drop. There would be a tendency towards a greater production of drops consisting of 4 primal drops than of drops consisting of 3 primal drops, and the process would be extended to the next drops of 8 primal drops and so on. As regards the primal drops, Dr. Kohler found two sets with diameters in the neighbourhood of 7μ and 8μ respectively, but the 7μ group was far and away the most frequent.

From an analysis of the rime deposited at the Halde Observatory from fog or cloud, Dr. Kohler found that the average amount of chlorine present was practically the same as the average amount found in rain water collected at Cirencester by Kinch. The actual amount present in samples of rime collected on different occasions varied very greatly. The average was about 3.5 milligrams per kilogram of rime, and the quantities on different occasions varied from 0.07 milligram to 56 milligrams. From an analysis of the results it was found that the same law existed among the chlorine amounts as among the sizes of the water drops; that is, amounts $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, or 2, 4, 6, 8 times the average amount, 3.5 milligrams per kilogram, were found, but there were practically no intermediate amounts. Dr. Kohler considers that the nuclei of condensation are nuclei of salt carried

into the atmosphere from the sea, and that these salt nuclei also follow the law of 2. The weight of the primal salt particle is computed to be 1.8879×10^{-22} grams. Drops of water in the atmosphere are therefore really salt solutions of greater or less strength. The strength depends upon the water vapour pressure and the temperature of the air. If the vapour pressure falls or the temperature rises, water is evaporated from the drops until the solution becomes strong enough to be in equilibrium with its surroundings and vice versa. As the growth or decrease of drops by such processes is continuous, there ought to be drops of all sizes, which is contrary to the law of distribution of sizes of drops found in the earlier part of the paper.

The paper is full of interest. The observations collected in it are invaluable, and the information about the range of sizes of drops from about 4μ to 20μ is most important. Dr. Kohler has endeavoured to apply in statistical sense the criterion which he himself enunciates, that if meteorology is to exist as an exact science, it is necessary to be critical of hypotheses even when they appear to be more or less well founded; but nevertheless one feels that independent testimony—dare one hope, from Scotland—is required of the law of 2, both in the size of drops and in the amount of chlorine present, before it can be included among the established facts of meteorology.

E. GOLD.

The Lunar Eclipses of 1927.

THERE are to be two lunar eclipses in 1927, about the middle and end of the year. Some of their relations to the earth's atmosphere are as follows:

JUNE 15, 1927.—The first eclipse is at its height (mid-eclipse) at 8^h 24.2^m, Universal Time, but the moon barely gets within the umbra on the north side of the earth's shadow. The radius of the geometrical umbra is $40'8$; the outer limb of the moon at mid-eclipse is distant $40'7$ from mid-shadow. At this moment the edge of the shadow nearest to the moon's limb is cast by the earth's surface and atmosphere at about W. $97^{\circ}3$, N. $63^{\circ}75$, in the neighbourhood of Baker Lake, which drains into Chesterfield Inlet, on the west shore of Hudson Bay. It would be interesting to know the weather, cloud, and sky conditions in this region at that moment. But the atlas indicates scarcely any population there.

In the eclipse of Nov. 4, 1892, the outer limb of the moon was $43'0$ from mid-shadow, the radius of the geometrical umbra was $45'4$, so that the immersion was deeper than in the coming case. But Gale, at Sydney, N.S.W., reported the limb so bright as to give the impression that the eclipse was not total; Russell, also at Sydney, said definitely that it was not total; Doberck, at Hong Kong, remarked on the brilliancy of the immersed limb. We may expect this time an opportunity to observe the density of the earth's shadow very near to the edge, but due to weather and climatic conditions very different from those which ruled in 1892. Then the grazing-point was over water, between Iceland and Norway, north of the Shetland Islands.

The last rays on the moon's limb at first contact with the umbra graze the earth's surface or atmosphere about W. $174^{\circ}7$, N. $32^{\circ}7$. This is at sunset on the open Pacific, north of Pearl and Hermes. The rays at last contact in like manner graze about W. $69^{\circ}1$, N. $17^{\circ}6$, a point at sunrise in the Caribbean Sea, considerably south of Catalina Island, south of Santo Domingo. Observations of weather, cloud, and sky at these points are desired, for comparison with direct observations of the shadow edge at these moments.

The two internal contacts at this eclipse come so

close together that they are scarcely separable from mid-eclipse. At mid-eclipse the sunrise-sunset line, centred about the sub-solar point at E. $54^{\circ}0$, N. $23^{\circ}3$, passes by Cape San Roque, Nova Scotia, Great Slave Lake, New Guinea, Gulf of Carpentaria, and Enderby Land. Of all this great circle, however, only a fraction, perhaps 35° , on the two sides of the Baker Lake region, is effective in illuminating the eclipsed moon.

DEC. 8.—The second lunar eclipse, on Dec. 8, with middle at 17^h 34.6^m, Universal Time, is of much deeper immersion, $11'$ or more at most, in the southern half of the shadow. The inner (north) limb of the moon just covers the middle of the shadow. The grazing light at the contacts comes from regions about the points indicated:

First Contact; E. $41^{\circ}6$, S. $25^{\circ}7$, in the Mozambique Channel, between Tulleur and Europa Island, at sunset.

Second Contact; E. $51^{\circ}0$, S. $51^{\circ}3$, in the Sea Tang, south of the Crozets, at sunset.

Third Contact; E. $164^{\circ}4$, S. $22^{\circ}0$, south-west of New Caledonia, at sunrise.

Fourth Contact; E. $157^{\circ}0$, S. $3^{\circ}5$, north-east of Bougainville Island, at sunrise.

Observations of weather, cloud, and sky at these points are desired, for comparison with observations of the shadow edge at the contacts.

At mid-eclipse the sunrise-sunset line is centred about the subsolar point at W. $85^{\circ}75$, S. $22^{\circ}7$, and passes over or near Kaiser Wilhelm Land, Fiji Islands, Sitka, Baffin Land, Cape Farewell, Timbuctoo, Mossamedes, Cape Town. The whole southern half of this great circle is effective in illuminating the eclipsed moon at this moment.

The mere naming of the grazing-points above indicates that observations within a few degrees of them are unlikely to be obtained. Still, it is desired that persons near any such, at sea or ashore, report their observations of weather, cloud, and sky at the sunrise or sunset moments indicated, either to a scientific journal or to the address, Lunar Eclipses, Harvard College Observatory, Cambridge, Mass., U.S.A.

University and Educational Intelligence.

CAMBRIDGE.—The Linacre Lecture will be delivered on Friday, May 6, by Dr. J. A. Murray, Director of the Imperial Cancer Research Fund, on the subject of "Multiple New Growths."

LONDON.—Applications are invited (until July 1) for the Laura de Saliceto studentship, of the annual value of £150, for the advancement of cancer research; also (until June 15), for grants from the Thomas Smythe Hughes Fund for assisting medical research. The applications should be addressed to the Academic Registrar of the University, South Kensington.

GLASGOW.—At the ceremony of graduation held on Saturday, April 23, the following University prizes, among others, were awarded: The Captain H. S. Ranken, V.C., Memorial Prize to the student who obtained the highest marks in the subject of pathology in the professional examinations held in the year 1926, to Andrew M. Wylie; Thomson Prize in geography for an essay on "The Economic Geography of the Lanarkshire Coalfield," to David W. Cousin; Bellahouston Gold Medals for eminent merit in theses for M.D. to Dr. George M. Wishart and Dr. Donald M'Intyre; Struthers Gold Medal and Prize for research on "The Development of the Vascular System in the Human Ovum prior to the Establishment of the Heart," to Dr. Donald M'Intyre.

ST. ANDREWS.—The University Court has appointed Dr. George J. Robertson, St. Andrews, to the lectureship in chemistry in the United College, vacant through the resignation of Dr. George MacOwan.

DR. PETER G. CARTER, of the Chemistry Research Laboratory, United College, University of St. Andrews, has been appointed to a lectureship in organic chemistry in the University of Sydney.

It is exactly two years since the Hebrew University of Jerusalem was inaugurated by Lord Balfour, and it is of considerable interest to examine the progress that has been made. An account of this progress is contained in a recent circular sent out by the Board of Governors. The work of the University is at present mainly directed towards research, and the lectures delivered are intended for graduate students. In the Institute of Jewish Studies and in the Arabic section of the School of Oriental Studies, a number of graduate courses are being delivered by twelve professors and lecturers. In the Institute of Chemistry, research workers are being trained, and many papers have been published. A Department of Hygiene has been organised to investigate problems in epidemiology. Important fundamental work has been carried out in the Department of Microbiology. An Institute of Palestine Natural History is being organised. Preparations are in hand for a Mathematics Department and for the erection of a Physics Department. Great progress has been made with the Library, which now has 140,000 volumes, and many valuable scientific collections have been acquired. The annual budget of the University is at present £35,000, and the academic staff numbers about fifty. Steps are being taken to widen the scope of the University, with special reference to the introduction of more extended teaching, and the consolidation of some of the chief departments and sub-faculties.

Calendar of Discovery and Invention.

May 1, 1843.—On this day was published the "Manual of British Botany," a work in which Charles Cardale Babington critically compared the native flora of Britain with continental plants.

May 1, 1866.—Recognised from the first as the leading meteorological journal of the world, the *Meteorologische Zeitschrift* was started by Julius Hann on May 1, 1866, and he continued to edit it with various colleagues until 1921. Its original name was the *Zeitschrift der Österreichischen Gesellschaft für Meteorologie*.

May 2, 1800.—Constructing a voltaic pile by the aid of the information in Volta's famous letter to Sir Joseph Banks in March 1800, Nicholson and Carlisle, on May 2, 1800, demonstrated that water could be split up into its constituent gases by the passage of a current of electricity. Their pile contained 36 half-crowns and 36 zinc discs.

May 3, 1715.—Down to the eighteenth century, accounts of total solar eclipses are meagre. That of May 3, 1715, was observed, however, by several astronomers in England, and Halley has left an interesting account of it. "I forbear to mention," he says, "the chill and damp which attended the darkness of this eclipse, of which most spectators were sensible and equally judges. Nor shall I trouble you with the concern that appeared in all sorts of animals, birds, beasts, and fishes, upon the extinction of the sun, since ourselves could not behold it without some sense of horror."

May 3, 1865.—While serving as a sergeant in the Garibaldian Wars of 1859, Pacinotti thought out the principle of the ring armature dynamo. He constructed such a machine in 1860, and described his invention on May 3, 1865, in the scientific journal *Il nuovo cimento*. Gramme's re-invention of the ring armature in 1870 was done without any knowledge of the work of Pacinotti.

May 5, 1707.—In his "Memoirs," Whiston says: "Mr. Cotes and I began our first course of philosophical experiments at Cambridge, May 5, 1707. In the performance of which certain hydrostatick and pneumatick lectures were composed: they were in number twenty-four, the one-half by Mr. Cotes and the other half by myself, which lectures were afterwards made use of in the like (enlarged) course which Mr. Hauksbee and I performed many years in London."

May 6, 1845.—On this day Wheatstone and Cooke patented the single needle telegraph instrument which has remained in use for more than eighty years.

May 6, 1886.—One of the most important contributions to the study of dynamo design was the paper on dynamo-electric machinery by John and Edward Hopkinson, read to the Royal Society on May 6, 1886. The first part of the paper was devoted to the construction of a characteristic curve for a machine of given dimensions, and the second part to a description of actual experiments with a dynamo, which were carried out at the Salford Iron Works of Mather and Platt.

May 6, 1896.—Commencing his experiments on planes moving through the air in 1887, Langley showed that relatively little power was required to sustain a given weight if the horizontal velocity reached a certain speed. Putting his ideas into practice, he made a steam-driven model aeroplane weighing about 25 pounds, which on May 6, 1896, at Quantico, Virginia, flew for about 1000 yards.

E. C. S.

Societies and Academies.

LONDON.

British Mycological Society, Mar. 19.—W. R. I. Cook: Influence of environment on *Ligniera Junci*. Examination of natural habitats shows that slightly acid water with excess of iron favours growth of the fungus. Laboratory experiments show that light is a more important factor in determining infection, as when exposed to light, roots are not infected and any existing infection disappears.—Miss M. P. Hall: Zonation in cultures of *Monilia fructigena*. Cultures show concentric bands of sterile mycelium with bands of conidia, which are controlled by the medium. The initial reaction should be acid unless growth induces acidity, and the concentration should not cause staling. Conidia are produced in light but not in darkness. Zonation can also be produced by temperature variation.—K. R. Mohendra: Variation in *Sphaeropsis Malorum*. Spores from a single pycnidium of a strain of *S. Malorum* gave two kinds of cultures, black and white. The ratio between the two was not constant, the whites increasing from three to one until the blacks had almost gone. Spores from a single white pycnidium gave white individuals only: spores from single black pycnidium gave mainly black but also a few white. The percentage of white colonies could be increased by repeated culture, but one strain gave only black individuals. White strains show a considerable amount of variation in spore formation.—E. Wyllie Fenton: Seed mixtures and incidence of fungal diseases. Plots grazed and mown for hay were sown with different seed mixtures. One of the grazed plots and all the hay plots were yellow with *Uromyces Dactylidis*. Absence of a reasonable amount of clover deprived the grasses of a sufficient supply of nitrogen.—E. H. Ellis: Fungi in Japanese carvings. An account of the fungi conventionalised in Japanese netsukes.

Physical Society, Mar. 25.—E. Mallett: Acoustical experiments with a mechanical vibrator. Preliminary experiments are described with a mechanical device vibrating a piston at one end of a tube so that a sound wave is emitted at the other. The particle velocities in the sound wave are measured by a Rayleigh disc, and resonance curves are drawn. The energy in the sound wave can be calculated from the results. The experiments are directed towards obtaining a standard source of sound, and the results are encouraging.—E. T. Paris: On the stationary-wave method of measuring sound-absorption at normal incidence. The apparatus differs from that used by earlier workers in the use of (1) a small tuned hot-wire microphone for determining relative pressure-amplitudes in the sound-waves; (2) the employment of a steady valve-driven source of sound with arrangements for maintaining the strength at a constant value; (3) the screening of source and experimental pipe from disturbances due to the movements of the observer. The relation between the response of the microphone and the amplitude of the pressure-variation in the sound-wave is eliminated.—J. H. Awbery and Ezer Griffiths: A ball and tube flowmeter suitable for pressure circuits. This robust form of the Ewing ball and tube flowmeter is suitable for the metering of gases or liquids under pressure, as for example the ammonia in a refrigerating plant. The necessary pressure-tight joints for connecting the conical tube to the circuit are described, and also a device for cutting off the flow should the tube fail.

Optical Society, April 7.—C. V. Raman: Huyghens' principle and the phenomena of total reflection. The

phenomena of total reflection are considered *de novo* from the viewpoint of the principle of Huyghens, which enables us to evaluate the disturbance appearing in the second medium when light is incident on the boundary between two media and is totally reflected into the first medium. The disturbance takes the form of a superficial wave moving parallel to the boundary and involves an acceleration of the reflected wave with reference to the incident wave, which is zero at critical incidence. The intensity of the superficial wave at critical incidence is greater for the component having the magnetic vector parallel to the surface, but diminishes more rapidly with increasing incidence than for the component having the electric vector parallel to the surface. The phase angle between the two components is an *acute* angle, in agreement with the classical treatment based on the Fresnel formulæ, but in disagreement with the conclusions of Lord Kelvin and Schuster.—H. W. Lee: The Hartmann formula for the dispersion of glass. The Hartmann formula is accurate within the limits of the Pulfrich refractometer. Optical glasses can be divided into three well-marked classes by their Hartmann constants, with linear relations between the constants in each class.

CAMBRIDGE.

Philosophical Society, Mar. 14.—G. I. Taylor: An experiment on the stability of superposed streams of fluid. Experiment to illustrate the stabilising effect of a density distribution similar to that which occurs in the air near the ground on a cold clear night. A stream of water flows over a coloured solution of salt. Instability sets in when the upper stream attains a certain velocity.—C. D. Ellis and W. A. Wooster: The absolute intensities of the γ -rays of radium-B and radium-C. The measured intensities of the groups in the β -ray spectra of these bodies, due to the internal conversion of the γ -rays in the atom that emits them, are used. The magnitude and rate of variation with frequency of the internal conversion coefficient is determined by considering the total energy and total number of the emitted γ -rays, both of which have been measured. To account for the measurements the internal conversion coefficient must vary approximately as the inverse 2.65th power of the frequency and have a value of 0.12 at a frequency corresponding to 3.54×10^5 volts. This result strengthens the evidence for physical reality of internal conversion. Using this co-efficient the intensities of the γ -rays are obtained directly from the intensities of the β -ray lines. One striking result is the amount of energy concentrated in the high frequencies.—P. M. S. Blackett: The limits of classical scattering. The condition given by de Broglie for the validity of geometrical optics is applied to the waves associated with a material particle; in particular to find the limits of classical scattering of α -particles by nuclei.—J. A. Gaunt: The stopping power of hydrogen atoms for α -particles according to the new mechanics. The classical theory of the stopping of α -particles agrees well with experiment, when account is taken of the transfer of energy to atoms at a considerable distance from the track. The limitations imposed by the stationary states of the old quantum theory seriously diminish the effect of the less close encounters. The new mechanics avoids this starvation of the more distant atoms. The deflexion of the α -particle is neglected. The excitation and ionisation of atoms at distances from the track, which are large in comparison with atomic dimensions, are calculated approximately by perturbation theory. The transfer of energy is nearly the same as on the classical theory.

DUBLIN.

Royal Dublin Society, Mar. 22.—L. B. Smyth: The index fossil of the Cleistopora zone. New material from Hook Head, Co. Wexford, together with a re-examination of the S.-W. Province specimens, shows that this is not a Cleistopora. It has a compact, fibrous coenenchyma, and a system of ring canals, and is therefore placed in *Vaughania* Garwood. M'Coy's *Astreopora antiqua* is considered, and the specific name rejected. The name *Vaughania vetus* is proposed. A portion of its ontogeny is worked out.—Dorothy Beckett: The influence of separation and pasteurisation on the size and distribution of fat globules in milk and cream. By direct measurement and counting on photographs at magnifications of 250 and 500 of samples of milk, in which the average diameter of globule was 3.7μ , and those larger than 6μ contained 9 per cent. of the fat, it was found that the distribution of the smaller globules was unchanged by the creamery process, but in the final cream 36 per cent. of fat was contained in globules ranging from 6μ to 24μ .—H. H. Poole: A convenient method of charging electroscopes. A well-insulated variable air condenser of capacity about $0.001\mu F.$, as used in radio reception, is set to its maximum capacity and charged from a battery or D.C. mains. It is then connected to the gold leaf, and by reducing the capacity the potential is raised to any desired voltage within the limit imposed by internal sparking. Initial voltages of either 80 or 220 were found to work well with the electroscope used, which, having a relatively heavy gold leaf, requires a large charging potential. Lower initial potentials could probably be used with many electroscopes, especially if a 'square law' condenser were used.

Royal Irish Academy, April 11.—J. L. Synge: Mathematical investigation of the thrust experienced by a cylinder of any section in a current of inviscid liquid, the motion being periodic and a regular train of vortices being formed. The formula obtained differs from that of Kármán, which only contains the first term. (2) Time measurement in an isotropic space-frame. The transitivity of simultaneity (if *A* is simultaneous to *B* and *B* is simultaneous to *C*, then *A* is simultaneous to *C*) is here proved on the simple assumption that the space-frame is isotropic with respect to light propagation.

PARIS.

Academy of Sciences, Mar. 21.—C. Matignon and Mlle. G. Marchal. The reducing properties of beryllium. The isolation of barium, magnesium, potassium, and aluminium. At a temperature of 1200° – 1300° C., *in vacuo*, beryllium gives no appreciable amount of vapour, and this, with its high heat of combustion in oxygen, renders this metal a valuable reducing agent. Details are given of the reduction of baryta to barium, magnesia to magnesium, potash to potassium, and alumina to aluminium. Lime is converted under the same conditions into calcium suboxide.—Pierre Termier: The tectonic problem of Vanoise and Mont-Pourri (Savoy Alps).—André Blondel: Rotating radiophares. A method for supplementing or replacing lighthouses by radio signal stations.—Léon Guillet and Albert Roux: The gases contained in brass, aluminium, and its alloys. Brass gives from 0.4 to 0.55 of its volume of gases (carbon dioxide and monoxide, hydrogen and nitrogen). Aluminium gave 0.14 of its volume of gas (carbon dioxide and monoxide and hydrogen).—Beniamino Segre: The cubic indicator of the linear projective

element of a surface.—Pierre Humbert: Differential equations which generalise Lamé's equation.—Octave Onicescu: The representation of a function by an ensemble of functions and the integral equations which result.—W. Margoulis: New experimental researches on the helices of helicopters.—P. Dejean: Hardening by traction, hardening by compression.—R. Wavre: The stratification of the planets in surfaces of equal density.—H. André: The electrical properties of some metallic compounds. Silver sulphide is capable of absorbing a certain quantity of sulphur at a low temperature. This mixture has an electrical conductivity which diminishes with rise of temperature, and is susceptible of numerous industrial applications.—Vaulot: The constants of a passive quadripole.—Léon and Eugène Bloch: The fluorescence of chlorine and bromine.—E. Doumer: The electrolysis of aqueous solutions of pure oxalic acid. A mixture of carbon dioxide and oxygen is evolved at the anode, the proportion varying with the current density.—H. Colin and Mlle. A. Chaudin: Mutarotation and the alkalinity of the medium. The action of soda and of ammonia on the change in rotation of glucose are parallel down to a concentration of $N/5500$.—W. Ipatief and Orloff: The hydrogenation of dibenzalacetone and of dibenzylacetone.—Roger Lyon, G. Fron, and M. Fournier: The characterisation of old wood as compared with green wood. Old stored wood has a different composition from new wood of the same species. This difference can be detected by microscopical observation or by measuring the hydrogen ion concentration of the water soluble extract.—Const. A. Kténas: Discovery of the lower marine Pliocene in the island of Nikaria (Egean Sea).—P. Martens: Vital observation of karyokinesis.—Henri Coupin: The influence of calcium on *Penicillium glaucum*. It is inexact to say that calcium is useless to *P. glaucum*, since its presence is necessary to the good formation of the conidia.—E. Miège: Sudden appearance of a barley with smooth beard.—Robert Lami: The liberation, following traumatism, of fungoid symbiosis of the young plants of *Cattleya*.—J. Dumont: The weight ratios of the reacting bodies in colloidal flocculations.—D. Bach: The nitrogen nutrition in the *Mucorinæ*. The assimilation of ammoniacal salts.—L. Ambard and F. Schmid: The excitability of the nerve centres as a function of their charge of hydrochloric acid.—Ch. Achard, Léon Binet, and A. Leblanc: Death in a superoxygenated atmosphere. An excess of oxygen over the normal atmospheric proportion causes death in animals. It is concluded that inhalations of pure oxygen used in therapeutics should not be too prolonged.—Charles Richet: Observations on the preceding communication. The author's observations made in 1904 confirm the conclusions given in the preceding paper. The composition of the atmosphere is an optimum for living beings and any change in either direction is disadvantageous.—Raymond-Hamet: The antagonism of hydrastinine and adrenaline.—J. Chevalier and Ripert: The pharmacodynamic action and physiological titration of preparations of flowers of pyrethrum.—E. Grynfeldt and H. J. Guibert: The genesis of the fibroid web of cicatricial tissue in experimental suppurations of the subcutaneous conjunctive.—Alfred Maubert: The influence of thorium-X on laccase. In doses between 1 and 5 micrograms, thorium-X causes an activation of laccase: in quantities of more than 10 micrograms, complete inactivation of the ferment is produced.—G. Levaditi: The sterilising action of bismuth in syphilis.—E. Ducloux and Mlle. G. Cordier: A method of immunisation by slow resorption of virulent antigens.

VIENNA.

Academy of Sciences, Feb. 24.—J. Hertzka: Relations between the fundamental chemical numbers.—D. Balarew: The equilibria between the hydrates of calcium sulphate.—T. Radakovic: The interpolation of functions of several variables.—F. Emich: The observation of 'streaks' (*Schlieren*) in chemical experiments. Toepler showed that the observation of flaws was one of the most sensitive methods in optics. This method is applied to testing with the microscope the purity and identity of small quantities of fluid distillates.—F. Trauth: Geology of the northern Radstädter Tauern and of their foot-hills.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 1, January).—George B. Kistiakowsky: The activation of gases by adsorption. Measurements were made in a glass vacuum calorimeter of the heats of adsorption of hydrogen on a copper catalyst, before and after poisoning by oxygen, and of carbon monoxide on the active catalyst. Some of the adsorbed gas appears to be activated by the fields of force surrounding unsaturated surface atoms; oxygen oxidises preferentially the most unsaturated surface atoms.—D. H. Kabakjian: Luminescence due to radioactivity. Three types of such luminescence exist. The first, shown by synthetic zinc sulphide under the action of α -rays after an equilibrium condition is reached, may be due to the destruction and re-formation of active centres in the substance. The second is shown by pure radium or radium bromide; the substance shows luminescence after heating. Certain stable molecular configurations are formed at high temperature and persist on cooling until attacked by an α -particle. The third type, thermo-luminescence, is shown by fluorite crystal. Energy is furnished by α -, β - or γ -rays and set free by molecular agitation in the crystal. The lower the temperature the more energy is absorbed, and heating the crystal afterwards intensifies the luminescence.—J. C. Slater: Radiation and absorption on Schrödinger's theory.—Carl R. Doering: The death rate from diphtheria in Massachusetts for 51 years, 1875–1925. In 1875 the death rate was nearly 200 per 100,000 of population; since then there has been a steady rate of decline of about 5.5 per cent. per annum. Figures for New York show a similar decline. The highest rates of decline (1892–1908) occur when the use of antitoxin and bacteriological diagnosis were spreading, but the figures are only doubtfully significant statistically.—Edward L. Thorndike: A fundamental theorem in modifiability. If a certain situation promotes one of a number of responses, the frequency of the use of one 'connexion' causing a certain response does not increase its strength at the expense of other 'connexions' causing different responses. Facilitation and inhibition among the 'connexions' from a situation cannot be explained by 'a drainage theory' towards the stronger 'connexion.'—N. D. M. Hirsch: A summary of some of the results from an experimental study of the East Kentucky mountaineers.—George H. Shull: Crossing over in the third linkage group of *Oenothera*. The gene for double flowers (*mut. supplea*) in *O. Lamarckiana* is closely linked with that for old-gold colour (*mut. vernaurea*); the crossing-over observed is considered to consist in the exchange of factors between the two chromosomes of the same pair.—G. A. Miller: Groups generated by two operators of order three whose product is of order three.

Official Publications Received.

BRITISH.

- Papers and Proceedings of the Royal Society of Tasmania for the Year 1926. Pp. iv+196+11 plates. (Hobart: Tasmanian Museum.) 10s.
- Union of South Africa: Department of Agriculture. Science Bulletin No. 52: Cost of Production of Waize; Report on the Investigation for the Season 1923–24. By D. W. McKellar. Pp. 23. 3d. Science Bulletin No. 58: The Manufacture of Loaf and Blended Varieties of Cheese. By Prof. H. B. Davel and D. J. Retief. Pp. 20. 3d. (Pretoria: Government Printing and Stationery Office.)
- Aeronautical Research Committee: Reports and Memoranda. No. 1060 (Ae. 243): Flying Positions of Control Surfaces of Bristol Fighter. By Capt. G. T. R. Hill. (A.2.b. Stability, Full Scale Expts., 40.—T. 2905.) Pp. 6+6 plates. 6d. net. No. 1068 (Ae. 250): The Full Scale Determination of the Lateral Resistance Derivatives of a Bristol Fighter Aeroplane. Part II: The Determination of the Rate of Turn Derivatives. By H. M. Garner. (A.2.b. Stability, Full Scale Expts., 43.—T. 2340.) Pp. 4. 3d. net. (London: H.M. Stationery Office.)
- Empire Cotton Growing Corporation. Report on the Characteristics of Several Crops that may be suitable as Rotation Crops with Cotton in East Africa and the Possibilities of Marketing Them in this Country. By H. C. Sampson. Pp. 23. (London: Empire Cotton Growing Corporation.) 1s.
- The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 65, No. 864, April. Pp. 389–468+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.
- The Carnegie United Kingdom Trust. Thirteenth Annual Report (for the Year ending 31st December 1926) submitted by the Executive Committee to the Trustees on Friday, 11th March 1927. Pp. ii+110. (Dunfermline.)
- The South African Journal of Science. Vol. 23: Being the Report of the Twenty-fourth Annual Meeting of the South African Association for the Advancement of Science, Pretoria, 1926, July 5–10. Pp. xlv+1150. (Johannesburg.) 35s. net.
- Board of Education. Vacation Courses in England and Wales, 1927. Pp. 21. (London: H.M. Stationery Office.) 6d. net.
- Journal of the Society of Glass Technology. Vol. 11, No. 41, March. Pp. x+11+97+124+xxxi. (Sheffield: The University.) 10s. 6d.
- Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1926. Pp. iv+496+90+11 plates. (London: H.M. Stationery Office.) 15s. net.
- Aeronautical Research Committee: Reports and Memoranda. No. 1057: On the Calculation of Stresses in the Hulls of Rigid Airships. By R. V. Southwell. (R. 33 Memorial Prize Essay, 1926.) Pp. 49. (London: H.M. Stationery Office.) 1s. 9d.
- Leeds University: Department of Pathology and Bacteriology. Annual Report, 1926, by Prof. Matthew J. Stewart and Prof. J. W. McLeod. Pp. 12. (Leeds.)

FOREIGN.

- Proceedings of the United States National Museum. Vol. 69, Art. 16: A Revision of the Parasitic Wasps of the Subfamily Braconinae occurring in America north of Mexico. By C. F. W. Muesebeck. (No. 2642.) Pp. 78+2 plates. Vol. 70, Art. 13: Contribution to the Anatomy of the Chinese Finless Porpoise, *Neomeris phocaenoides*. By A. Brazier Howell. (No. 2622.) Pp. 43+1 plate. Vol. 70, Art. 16: Foraminifera of the Genus *Ehrenbergina* and its Species. By Joseph A. Cushman. (No. 2665.) Pp. 8+2 plates. Vol. 70, Art. 20: The Occurrence and Properties of Chlorophenolite, a new Arsenate from Franklin, New Jersey. By William F. Foshag, Harry M. Berman and Robert B. Gage. (No. 2669.) Pp. 6. Vol. 71, Art. 2: The Beetles of the Family Cleridae collected on the Mulford Biological Exploration of the Amazon Basin 1921–1922. By Edward A. Chapin. (No. 2674.) Pp. 10. (Washington, D.C.: Government Printing Office.)
- Publications of the Kapteyn Astronomical Laboratory at Groningen. Edited by Prof. Dr. P. J. van Rhijn. No. 41: The Proper Motion and the Distance of the Praesepe Cluster. By Dr. W. J. Klein Wassink. Pp. 48. (Groningen: Houtsema Bros.)
- Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 18, Part 4: The Ticks Parasitic on Cattle and Horses in Hokkaido, Japan. By Kisajiro Ogura and Koji Takada. Pp. 199+206+plates 11–15. (Sapporo.)
- Contributions to Embryology. Vol. 18, Nos. 90–97. No. 90: Cultivation of Embryonic Heart Muscle, by Warren H. Lewis; No. 91: Correlation of External Genitalia and Sex-Glands in the Human Embryo, by Karl M. Wilson; No. 92: The "Miller" Ovum—the Youngest Normal Human Embryo thus far Known, by George L. Streeter; No. 93: Detailed Form of the Wolffian Body in Human Embryos of the First Eight Weeks, by Juiro Shukinami; No. 94: Lens Ectoderm and Optic Vesicles in Allantois Grafts, by Vera Danachoff; No. 95: Menstrual Records and Vaginal Smears in a Selected Group of Normal Women, by Jessie L. King; No. 96: Transformation of Mononuclear Blood-Cells into Macrophages, Epithelioid Cells and Giant Cells in Hanging-Drop Blood-Cultures from Lower Vertebrates, by Margaret R. Lewis and Warren H. Lewis; No. 97: Origin of Thrombocytes and of the Different Types of Blood-Cells as seen in the Living Chick Blastoderm, by S. Sugiyama. (Publication No. 363.) Pp. iii+147+39 plates. (Washington, D.C.: Carnegie Institution.) 5.75 dollars.
- Anatomical Texts of the Earlier Middle Ages. A Study in the Transmission of Culture. By Prof. George W. Corner. With a revised Latin Text of *Anatomia Cypriaca* and Translations of Four Texts. (Publication No. 364.) Pp. 112+3 plates. (Washington, D.C.: Carnegie Institution.)
- Environment of Tetrapod Life in the late Paleozoic of Regions other than North America. By E. C. Case. (Publication No. 375.) Pp. iii+211. (Washington, D.C.: Carnegie Institution.) 2.50 dollars.
- Bulletin of the Geological Institution of the University of Upsala. Founded by H. Sjögren. Vol. 20. Pp. 286+6 plates. (Upsala: Almqvist & Wiksells Boktryckeri A.-B.)

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 1: Educational Directory, 1927 Pp. iii+189. (Washington, D.C.: Government Printing Office.) 20 cents.

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1915 Rédigées par Bruno Rolf. Pp. ii+76. (Stockholm: Almqvist and Wiksells Boktryckeri A.-B.)

CATALOGUES.

Catalogue of Scientific Books and Publications of Learned Societies; including a Selection from the Library of Prof. Alfred Denny. No. 284. Pp. 82. (Cambridge: W. Heffer and Sons, Ltd.)

Bulletin No. 81: The New "Sonic" Flat Potter-Bucky Diaphragm. Pp. 4. (London: Watson and Sons (Electro-Medical), Ltd.)

Diary of Societies.

SATURDAY, APRIL 30.

BRITISH PSYCHOLOGICAL SOCIETY (General Section) (jointly with the Cambridge Psychological Society) (at the Psychological Laboratory, Cambridge), at 2.30.—Prof. A. Michotte: Experiments on Learning to Perform Skilled Movements.—At 4.—Demonstrations: The Study of Long Spells of Repetition of a Skilled Task, Miss K. Pollock; An Experiment in Divided Attention, Miss E. J. Lindgren; Peripheral Visual Perception, M. Solaman; Learning to Perform Movements, Miss Blair and Miss Davis; Experiments on Reading, R. W. Pickford; Real and Illusory Visual Movements, Dr. H. de Silva; Constructive Imagination, Dr. E. Hutchinson; The Visual Effects of Flicker, Dr. Buchanan; Apparatus for the Study of Motor Elements of Skill in Shooting, Dr. Banister; Plateaux in a Learning Curve, Mrs. Drury Smith; Localisation of Sound, P. Vernon.—At 5.45.—Symposium on the Relevance of Visual Images to the Process of Thinking—Prof. T. H. Pear, Dr. F. Aveling, F. C. Bartlett.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 8.—W. S. Rider: Feeding and Treatment of Animals below Ground and Stabling.—Paper open for further discussion: The Ventilation of a Pyrites Mine, with special reference to Fire-fighting, Safety, and Rescue Work, R. White.

MONDAY, MAY 2.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in the Museums, Cambridge), at 4.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting. SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—O. Brunler: The Internal Combustion Boiler (Brunler Flame).

ROYAL SOCIETY OF ARTS, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (2).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (Annual Meeting) (at Chemical Society), at 8.—F. Tattersfield and C. T. Gillingham: Recent Investigations on Contact Insecticides.

TUESDAY, MAY 3.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Gordon Douglas: The Co-ordination of the Respiration and Circulation with Variations in Bodily Activity (Oliver-Sharpey Lectures) (1).

ROYAL SOCIETY OF MEDICINE (Orthopaedics Section), at 5.30.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Prof. H. C. H. Carpenter: Some Recent Services of Metallurgy to Engineering (James Forrest Lecture).

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.—F. Martin Duncan: The Lore of the Bee.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. J. Hargreaves: Amateur Astronomical Photography.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.

WEDNESDAY, MAY 4.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 5.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—C. F. Elwell: The Holweck Demountable Type Valve—H. Morris-Airey, G. Shearing, and H. G. Hughes: Silica Valves in Wireless Telegraphy.—W. J. Picken: Cooled-Anode Valves, and Lives of Transmitting Valves.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. W. R. Schoeller and C. Jahn: Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. VII. The Precipitation of Tungstic Acid by Tannin. VIII. The Separation of Tungsten from Tantalum and Niobium.—S. G. Clarke: The Separation of Vanadium and Tungsten.—J. M. Jones and T. McLachlan: The Determination of Moisture by the Volatile Solvent Method—F. Wokes and Dr. S. G. Willmott: A Study of Antimony Trichloride as a possible Quantitative Reagent for Vitamin A.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. E. Dalby: English Railways (Dr. Mann Lectures) (1).

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

EUGENICS SOCIETY, at 8.

FOLK-LORE SOCIETY (at University College), at 8.—Mrs. Murgoci: Vampires in Roumania.

THURSDAY, MAY 5.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Presentation of Bessemer Gold Medals to A. Wahlberg and Prof. C. Benedicks.—F. W. Harbord: Presidential Address.—J. Seigle: Some Aspects of the Technical and Economic

Conditions of the Heavy Metallurgical Industry of the East of France, with Particular Reference to the Utilisation of Gases and Motive Power.—Prof. W. A. Bone, L. Reeve, and H. E. Saunders: An Experimental Inquiry into the Interactions of Gases and Ore in the Blast-Furnace.—At 2.30.—Sir Robert Hadfield: (a) The Metal Manganese and its Properties; Also: The Production of Ferro-Manganese and its History; (b) Low-Carbon Alloys of Iron and Manganese.—Alloys of Iron Research. Part V. Introductory, Dr. W. Resenhajn. Preparation of Pure Chromium, F. Adcock. Part VI. Preparation of Pure Manganese, Marie L. V. Gayler. Part VII. Preparation of High Purity Silicon, N. P. Tucker.—Part VIII. The Constitution of Alloys of Iron and Phosphorus, J. L. Haughton.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Gordon Douglas: The Co-ordination of the Respiration and Circulation with Variations in Bodily Activity (Oliver-Sharpey Lectures) (2).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

CHEMICAL SOCIETY, at 8.—W. Hanhart and Dr. C. K. Ingold: The Nature of the Alternating Effect in Carbon Chains. Part XVIII. Mechanism of Exhaustive Methylation and its Relation to Anomalous Hydrolysis.—H. Bassett and R. G. Durrant: The Interrelationships of the Sulphur Acids.

FRIDAY, MAY 6.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—E. A. Atkins: The Drawing of Steel Wire and its Relation to Qualities of Steel.—Dr. W. H. Hatfield: Heat-Resisting Steels.—Prof. C. A. Edwards and J. C. Jones: The Influence of Annealing Temperature on the Properties of Mild Steel Sheets.—T. Swinden and G. R. Bolsover: Some Notes on Cold-Rolled Strip Steel.—B. Yaneske: The Manufacture of Steel in India by the Duplex Process.—At 2.30.—Prof. C. Benedicks and H. Lofquist: Theory of the Growth of Cast Iron Repeatedly Heated.—J. H. Andrew and H. A. Dickie: The Ac Range in Special Steels.—J. H. Andrew, M. S. Fisher, and J. M. Robertson: The Properties of Some Nickel-Chromium-Molybdenum Steels.—Prof. K. Honda and K. Takahashi: A Further Investigation of the Indentation Hardness of Metals.—T. Matsushita and K. Nagasawa: The Phenomenon of Temper-Hardening in Steels.—S. Tamura: Notes on Pseudo Twinning in Ferrite, and on the Solubility of Carbon in Alpha Iron at the A₁ Point.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—B. C. Allen: Assam.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion on Latitude Observations), at 5.—Chairman: Prof. A. S. Eddington. Speakers: P. H. Wade, Dr. J. Jackson, and others.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Group Meeting.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane, E.C.), at 7.—Annual General Meeting and Members' Evening.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. A. Sallis: Durham Burn's Paper.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—L. J. Chubb: The Geological Work of the St. George Expedition to the Pacific Ocean.—H. B. Milner, A. J. Bull, G. S. Sweeting, and F. E. Eames: The Geology of South-East Suva.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Annual General Meeting) (at Imperial College of Technology), at 8.—Dr. W. R. Ormandy: Chemical Fire Extinguishers.

PHILOLOGICAL SOCIETY (Anniversary Meeting) (at University College), at 8.—Z. Arand-Choinski: The Inter-Verbal Phonetics of Cursor Mundi.

ROYAL SOCIETY OF MEDICINE (Anaesthetics Section), at 8.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Major A. Corbett-Smith: China and the Real Chinese.

SATURDAY, MAY 7.

ROYAL SOCIETY OF MEDICINE (Otolaryngology Section), at 10.30 A.M.—Annual General Meeting.

PUBLIC LECTURES.

SUNDAY, MAY 1.

GUILDHOUSE (Eccleston Square S.W.), at 3.30.—R. A. Smith: Religion in the Late Stone and Bronze Ages.

MONDAY, MAY 2.

UNIVERSITY COLLEGE, at 8.30.—Prof. R. W. Chambers: Philology at University College.

TUESDAY, MAY 3.

UNIVERSITY COLLEGE, at 4.30.—Prof. J. S. B. Stopford: Sensation and the Sensory Pathway. (Succeeding Lectures on May 4 and 6.)

KING'S COLLEGE, at 5.—Prof. R. J. S. McDowall: Autonomic Nervous System. (Succeeding Lectures on May 10, 17, and 24.)

MEDICAL SOCIETY OF LONDON, at 5.15.—Sir Thomas Legge: The Teaching of Industrial Medicine (Chadwick Lecture).

GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on May 4, 5, and 6.)

WEDNESDAY, MAY 4.

ROYAL COLLEGE OF SCIENCE, at 5.—Dr. P. Chalmers Mitchell: Logic and Law in Biology (Huxley Memorial Lecture).

THURSDAY, MAY 5.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. C. Frausnitz: Experimental Researches on the Nature of the Bacteriophage.



SATURDAY, MAY 7, 1927.

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Co-operation in Research throughout the British Empire.

ONE of the most useful discussions at the Congress of the Universities of the Empire held at Cambridge last year, the official Report¹ of which has been published, was on "Co-operation in Research throughout the Empire." The subject is so attractive and appropriate to the times in which we are living that one may be pardoned for overlooking how modern is the idea of co-operation in the field of scientific research. Diogenes living in his tub, and asking nothing of the kings and satraps of the world except to get out of the sunlight, represents the traditional conception of a philosopher. Newman, in the preface to his "Discourses on the Scope and Nature of University Education," insists on the necessary solitude of the scientific investigator. "The common sense of mankind," he says, "has associated the search after truth with seclusion and quiet." The greatest thinkers are men of absent minds and idiosyncratic habits. Pythagoras lived for a time in a cave; Thales refused the invitation of princes. Friar Bacon lived in his tower upon the Isis; Newton in an intense severity of meditation which almost shook his reason. Who among his contemporaries, we may well ask, could claim to share the labours

"Of Newton, with his prism and silent face,
The marble index of a mind for ever
Voyaging through strange seas of Thought,
alone"?

In Newman's opinion, to discover and to teach are distinct gifts, not commonly found in the same person. This idea may explain the tentative way in which the teaching universities of Great Britain took up the work of scientific research. In Victorian Oxford, the Rev. C. L. Dodgson—better known as Lewis Carroll, the author of "Alice in Wonderland"—ridiculed the claims of science to a place in university curricula. Science, he says, sat weeping at the gates. Oxford admitted her and housed her royally, adorning her palace with retorts and reagents and making it a charnel-house of bones. When the students sniffed at the sulphuretted hydrogen and turned away, science said: "Give me no more youths to teach; and pay me handsomely and let me think." Making allowance for the whimsicality of the author of "Alice in Wonderland," we may acknowledge a modicum of truth in this description of the origin

¹ Third Congress of the Universities of the Empire, 1926: Report of Proceedings. Edited by Alex. Hill. Royal 8vo. Pp. xxvii+270. (London: G. Bell and Sons, Ltd., 1926.) 21s. net.

of scientific research at Oxford. The sister university organised its research work more deliberately; but only in recent years has scientific research received full recognition in our ancient universities.

As to the Government, nothing less than the greatest war in history was necessary to bring about active participation in this work. The bombs from enemy airships were actually dropping on London when the organisation of the Department of Scientific and Industrial Research was in progress. The Dominions—Australia, Canada, South Africa, and New Zealand—and India followed the example of the mother country. Not yet, however, as is shown by the discussion at the Universities Congress, have all the problems of co-operation in the field of scientific research found their solutions.

Sir Thomas Holland in his opening address to the Congress gave a résumé of the scientific activities within the Empire stimulated or organised during the War. Established streams of international exchange were altered by the War. For example, the output of wolfram in south Burma, the principal source of that mineral, was before the War sent to Germany, and the tungsten extracted therefrom, an important constituent of tool-steel, was rationed to English firms. Some precious months of intensive research under the compelling impetus of war were necessary to elucidate a satisfactory process of manufacture; but that, Sir Thomas Holland said, was only “one of the many shocks which followed the winter operations of 1914–15.” In the light of such an experience, the need for “official organizations for correlation and control” could scarcely be disputed. Their relations to British universities and industries are still in process of adjustment. Sir Thomas Holland was not disposed to accept Newman’s dictum regarding the independence of teaching and research. The highest teaching, he said, loses its vitality if unconnected with research.

Conversely, the question arises: To what extent and in what directions does research suffer if divorced from teaching? Sir Thomas did not suggest that there was any lack of co-operation between the Department of Scientific and Industrial Research and the universities, for the Department had shown a willingness to hand over problems to research workers in university laboratories and also to assist new researches proposed by university professors. But the establishment, at home and in the Dominions, of special research institutes, wholly divorced from

teaching, was a new development. Certain forms of research must be conducted on a scale beyond the capacity of the ordinary university or college. Research workers always have more ideas than they can readily develop and complete in practice, and there is a greater tendency to reserve a ‘claim’ in a general institute, the governing body of which may not be composed of critical specialists. This danger, however, is not apparent in Great Britain so far.

Sir John Farmer addressed himself to a problem of great Imperial interest—the work of the scientific officers attached to the agricultural departments in the Colonies and of the officers of the commercial agricultural enterprises which are growing up, especially in the tropics. These officers do their work in a solitude due to physical reasons, and Sir John Farmer’s appeal to the home universities to assist them by offering a welcome to the university laboratories during their visits to the mother country should meet with an enthusiastic response. For, as he said, no one has a better right to this hospitality than the man who has been coping with problems under conditions of difficulty which would astonish those who have been accustomed to the luxurious resources of some of the modern temples of science.

A good example of the importance of agricultural problems of the tropics was given by Sir Arthur Shipley. Last year we imported 60,000,000 bunches of bananas, each containing about 80 bananas, and thus the inhabitants of the British Isles consume about 100 bananas per head a year. But many of the plantations are derelict owing to the banana disease, and any one who could find a cure for the fungus which destroys the banana would make a fortune. It is to be hoped that the prognostication will be confirmed, though there are instances, *e.g.* the discoveries relating to the transmission of malaria, which would discourage over-confidence of financial reward. However, the colonial scientific research service has many attractions for the enthusiastic worker, as Sir John Farmer insists, and his appeal for “the fertilising effects of intercourse with others who are pursuing similar or analogous paths of scientific work” refers to a psychological aspect of the question of co-operation in research the importance of which it would be difficult to overstress. As a good example of co-operative research, he instanced the work of the Food Investigation Board, under the able direction of Sir William Hardy. Scientifically, the work is mainly rooted in Cambridge, with a smaller root system in London. The essence of its

success was to be found, he suggested, in the completeness of the chain of co-operation.

Dr. Andrew Balfour, Director of the London School of Hygiene and Tropical Medicine, also discussed the Imperial aspects of the question, emphasising the waste of time, money, and energy, "owing to the fact that in the great and important domain of tropical medicine men are, to a large extent, working in watertight compartments." Thanks to the Colonial Office, things are improving, and he commended also the work accomplished in India by the Scientific Advisory Board.

The important part which India is destined to play in the promotion of scientific research was well brought out by several Indian speakers. As Sir Jagadis Bose said, there has never been in India any real conflict between religion and knowledge. Those who pursued knowledge regarded themselves as dedicated to a sort of religious life. "In India," he said, "we combine all these qualities—inner vision, power of invention, control of our hands." India is determined to be the brightest jewel in the Imperial crown by reason of its contribution to the spiritual wealth of the British Empire. If the spirit of co-operation in research can be developed, the Empire will become, as Prof. Radhakrishnan said, "a spiritual whole" and thus serve the interests of humanity.

T. LL. H.

The Work of the British Geophysical Observatories.

Air Ministry: Meteorological Office. The Observatories' Year Book, 1923: comprising the Results obtained from Autographic Records and Eye Observations at Lerwick, Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), Richmond (Kew Observatory), and Benson. Published by Authority of the Meteorological Committee. (M.O. 279.) Pp. 371 + 12 plates. (London: H.M. Stationery Office, 1926.) 63s. net.

ONE of the important functions of the Meteorological Office is the maintenance and administration of the observatories at Lerwick, Aberdeen, Eskdalemuir, Valencia, Benson, and Kew, at which a considerable variety of geophysical work is done. The volume under review is the record of that work for 1923 and forms the second of a series which replaces certain sections of the well-known "British Meteorological and Magnetic Year Book." The evident purpose of the new series is the collection in compact form of all the work done at each observatory.

The six institutions named differ in their aims and, apparently, in the power of their equipment to deal with the wide range now covered by geophysical investigations. Lerwick Observatory, opened in 1921, is as yet confined to terrestrial magnetism, and even for this subject the staff and equipment have been so restricted that the enormously important work waiting to be done there cannot be undertaken. Aberdeen is concerned solely with meteorology and has earned a high reputation in the study of cloud forms. Eskdalemuir is primarily a magnetic observatory, but includes atmospheric electricity, seismology (since removed to Kew), and meteorology. Kew, after a long and honoured record of research in terrestrial magnetism, is changing in character and its present functions appear to be somewhat indefinite. Benson has been occupied with work on the upper air, but has been closed on this work being transferred to Kew. Valencia is a 'first order' meteorological station and includes in its programme a weekly observation of the magnetic elements.

Such diversity of aim is explained by the historical development of each observatory, and chiefly by the circumstance that, in their origins, they are not all creations of the Meteorological Office. From one point of view it may be regarded as an element of strength rather than of weakness. The important matters are, first, that where their aims are common their results should be comparable; and, secondly, that in each subject of inquiry or record, its distribution among the observatories should provide an adequate representation of the area with which they are supposed to deal.

With regard to the first of these, the volume now under review gives ample evidence of the care taken by the Meteorological Office to bring its records to a common measure. Take, for example, the hourly readings of atmospheric pressure at Aberdeen, Eskdalemuir, Valencia, and Kew. In all respects, except that of height above sea-level, they are entirely comparable, and the inquirer is not maddened by doubts as to the exact position of the recording instrument, the times and methods of observation, the units employed, and the corrections applied. Nor is he referred for information on such matters to some former publication to which he may not have immediate access. The same may be said of records of temperature, humidity, sunshine, and rainfall at these four stations. Although it would be absurd to become dithyrambic over the thousands of columns of figures in these tables, they recall Gibbon's praise of the learned Lutheran's

encyclopædic treatise, for they are "full, rational, and correct." Closer scrutiny, it is true, will reveal minute differences in observatory practice in compiling some of the other tables, but, except in one, they are not serious. Aberdeen seems to enjoy a monopoly in atmospheric optical phenomena. Further, the occurrence of such phenomena is entered sometimes under the appropriate hour, sometimes in the "Remarks" column, and sometimes in both. Unusual visibility is frequently recorded by the Beaufort letter, occasionally by the Beaufort symbol, and may appear indifferently under the hour or in the "Remarks." The exception referred to is that of wind measurement, for there is still a distressing variety in the instrumental means employed for the purpose at the different observatories. But taking them as a whole, there can be nothing but praise for the laborious care which has been bestowed on the preparation of these fundamental tables.

The second point referred to above may be fitly exemplified by considering the arrangements for continuous registration of wind over the British area. For a comprehensive study of this subject the materials are, as yet, far from complete. In addition to the observatories there are about thirty other anemometric stations within the area. But their distribution cannot be regarded as satisfactory. About half of them are to be found along or close to the English Channel coast, and it is abundantly evident that their increase in recent years has been rather in the interests of the applications of meteorology to aviation, than in those of the pure science itself. Here, as elsewhere, it must be insisted upon that in the last analysis these latter interests must be predominant. Again, considering the importance to the study of British weather of the frequent depressions in the Icelandic region, one would expect that the north-west coast of Scotland might be represented in the distribution. But until the establishment last year of a new anemometric station on the island of Tiree, this area was a blank. Information is still required from such places as St. Kilda, North Uist, and from Lerwick Observatory, where wind blows with an intensity unknown to the Sassenach. The wind data from the observatories published in this volume are as complete as can be reasonably expected and are admirably arranged. The annual distribution of frequency might be supplemented by the figures for previous years, for these are not in all cases readily accessible. Prof. Becker has published results which would indicate a very marked decrease in the frequency of high winds

over the Glasgow district during the last half-century, and it is more than a merely superficial impression which inclines one to the belief that there has been a parallel decrease in the frequency of gales in the North Sea. It would be of interest to have these conclusions examined.

It is not the object of the "Year Book" to give any discussion of general results deducible from the meteorological data. A partial exception to this general rule is to be found in the harmonic analysis of diurnal variations of atmospheric pressure at Eskdalemuir, Valencia, and Kew, and of temperature at the two latter stations. Those for Aberdeen are not given, for some reason unexplained. This extension of the tabulated data is most welcome. But it is hoped that it will not be taken as an indication of ingratitude if a request be made for still more; that is, that the hitherto unpublished series 1913-21 be similarly analysed and issued. The subject of the diurnal variation of pressure—to which the present Director of the Meteorological Office has already made a notable contribution—is by no means exhausted, but its advance in some directions is largely impeded by the lack of trustworthy data. It may also be suggested that the value of the "Year Book" would be considerably enhanced if similar records were obtainable from Lerwick Observatory, almost the only station in the northern hemisphere providing an exposure free from the influence of large land areas, which have such marked effects on the different terms of the harmonic expansion. As Sir Napier Shaw once remarked on a parallel case, it is "somewhat depressing that the world should be content to go on without the knowledge which is needed for calculations such as this, and which is within the reach of effort." It is well known that the solar part of the diurnal pressure inequality is affected by some of the various factors which make up the meteorological character of the day, and among these, principally, the occurrence of deep depressions, with the consequent uncertainty as to the distribution of non-cyclic change. For the investigation of such effects the new arrangement of the "Year Book" is especially well adapted, since nearly all the information required for any classification of days is given in the volume.

The magnetic data published in the "Year Book" are chiefly those from Eskdalemuir, and they are given with a completeness which leaves little scope for criticism. Full details of the bi-weekly absolute determinations of D , H , and I are given, together with the base-line values, both deduced and adopted, of the N , W , and V magnetographs. But

there is, as yet, no indication of the use of modern electromagnetic methods for these fundamental determinations. The tabular matter includes hourly values of the three geographical components; hourly means for each month, and daily means for each day; maximum and minimum for each day, with the time of occurrence; absolute daily range, and the magnetic 'character' of each day. The diurnal inequalities are given very fully for 'all' days, quiet days, and disturbed days, and they are further expressed in terms of their harmonic components. The series of notes on the magnetograms of the year are of interest, for they provide abundant matter for speculation and study. What makes these notes of value is that there appears to be a better prospect of elucidating terrestrial magnetic disturbance by the study of the same disturbance in the records of several stations, than by lumping together all disturbances at one station. For example, there is sound reason for the full investigation of the diurnal variation on the same magnetically quiet days at all stations. But similar inquiry on highly disturbed days introduces elements of great uncertainty, chiefly dependent on the selection of days regarded as disturbed, on the hour of day at which a disturbance begins, and on the fact that disturbances are not all of one type. This is borne out by the vector diagrams shown in the "Year Books" of 1922 and 1923. For quiet days there is practical constancy in type for the respective seasons, while for disturbed days there is marked variation in type. But the more intensive study of the details of each world-wide magnetic storm involves a degree of international co-operation which is, as yet, far from realisation.

The magnetic results from the new observatory at Lerwick appear for the first time in this issue of the "Year Book." Until the instruments have settled down—there was heavy 'drift' on the *H* magnetograms—the published data are confined to diurnal inequalities of the horizontal components, daily range in declination, and to general annual results. These show that magnetic disturbance at Lerwick is on a much larger scale than at Eskdalemuir, itself a fairly disturbed station. For example, the daily range in declination at Lerwick on Sept. 27, 1923, exceeded $2\frac{1}{2}^{\circ}$ —very much greater than it would have been at Eskdalemuir. Dr. Chree contributes an interesting discussion of the chief results. The volume also includes a summary of the auroral log of the observatory, but this is practically confined to a list of the fifteen dates on which auroræ were visible. The powers that are swayed by the "interests of brevity," to which

apologetic reference is made, have evidently been at work. Nothing is said as to any extension of the auroral work, one of the chief objects for which this observatory was established.

Eskdalemuir Observatory contributes its earthquake and microseismic records, and these are given in full. In connexion with the latter, there are interesting notes intended as comment on the theory that microseismic amplitude and the travel of cyclonic depressions over the European area are correlative. The agreement with the Strasbourg microseismic record is at times very striking. Among minor, but not the less important and interesting, subjects there may be noticed the atmospheric potential gradient measurements at Eskdalemuir and Kew; the record of atmospheric pollution at Kew; and the soundings by registering balloons sent up from Benson.

The "Year Book" is the record of an immense amount of laborious work in measurement, tabulation, and computation. Much of it, necessarily, is of the nature of that routine which tends to diminish zeal, but the work has been carried through on a level, in respect of quality, which commands nothing but praise. The Meteorological Office has many functions to fulfil. Some of these—forecasting weather, for example—are of general importance; others—among which may be classed the provision of information for aviators—are significant of administrative accident rather than of importance in themselves. But it has also the paramount obligation of providing the material for the advancement of that science upon which its own activities are based. The present substantial addition to the published data of geophysics is a welcome evidence that this responsibility is being discharged, and on its issue the Meteorological Office must be congratulated.

A. CRICHTON MITCHELL.

Geology of South Africa.

The Geology of South Africa. By Dr. Alex. L. Du Toit. Pp. xi + 463 + 39 plates. (Edinburgh and London: Oliver and Boyd, 1926.) 28s. net.

SOUTH Africa is characterised geologically by its unity in plan and its variety in structure and composition. It is of special interest to European geologists, as its Karroo formation is an important supplement to their records, as it claims to be the original home of reptiles, mammals, and man, and as it contains the most prolific of the world's goldfields and diamond mines, and the largest known supply of primary platinum ores.

Its present unity and isolation are due to Mesozoic movements that severed it from South America and Australia, which have many features in common; for the three areas shared the same early geological history, presenting, however, the differences that might be expected from such far-distant sections of the same continent.

The geology of South Africa is well adapted to individual treatment, and it has been described in an excellent series of text-books, of which that by Dr. Du Toit is the latest and most complete; it will be exceptionally useful from its concise statement of the evidence, its references to the literature, its beautiful map, clear plates and diagrams, and the author's sound and cautious judgment. His caution is shown in dealing with the oldest South African rocks. He is confident that they are pre-Devonian, but how far they are Palæozoic or pre-Palæozoic he leaves open. The Waterberg Sandstone he treats as early Palæozoic, though no fossils have been found in it; the reviewer in 1915, when describing its north-western extension in Angola, adopted its pre-Palæozoic age somewhat tentatively, but the later evidence and drift of opinion are in favour of that conclusion.

The view that the Waterberg Sandstone is the inland equivalent of the Devonian Table Mountain Sandstone, and that the underlying dolomites are Ordovician, has had a strong appeal to South African geologists; and it was strengthened by the claim that *Orthoceras* had been found in the Otavi Dolomite; but as there is no mention of that fossil, it may be assumed that the author dismisses it as a concretion. The most important formation amongst the earlier rocks is the Banket of the Transvaal goldfield. The author discusses whether its gold was alluvial or due to infiltration, and says that the criteria are indecisive (p. 69); but he adds that "the placer theory appears by far the most likely," and in his final chapter he gives a graphic summary of the geological history of the field, which follows exactly the views urged by the reviewer in 1907, including the formation of the pyrites from black iron sand, the shaping of the typical Banket pebbles by beach action, the alluvial origin of the gold, and its recrystallisation, and the existence of gold in washouts through the Banket and of pebbles of that rock in the Ventersdorp conglomerates. The facts show that the gold is earlier than the Ventersdorp igneous activity to which it is attributed by the advocates of infiltration. The main difference is that Dr. Du Toit describes the pebbles as muffin-shaped instead of bun-shaped. Dr. Du Toit rejects the view of

Dr. Mellor that the Banket was formed by a sudden deltaic flood, and adopts the earlier view that it was formed by long-continued surf action on a sinking shore. The Banket of Southern Rhodesia, which was formerly claimed by most South African geologists as a crush conglomerate, the author accepts as sedimentary.

One especially valuable section of the work is the up-to-date account of the Karroo System, and of its reptiles and correlation. It includes an admirable description of the Upper Carboniferous glacial deposits and glaciated surfaces. The author represents the glaciation as radiating from four centres, of which one lay to the east of the present coast. He accepts the age as Upper Carboniferous, and deplores the use in Australia of "that unfortunately misleading term Permo-Carboniferous" . . . "an illogical practice that has immensely obscured the true issue." Fortunately the Australian Permo-Carboniferous is now restricted within comparatively narrow limits. The famous Dwyka glaciation was not the first in South Africa, as the author describes the evidence for that in the Transvaal Period from Griqualand and Namaqualand. The coal of the Karroo does not rest on underclay, and the roots of the fossil forest described spread over the top of the coal as if the trees had spread over an accumulation of vegetable matter on the emergence of the land. There is a valuable synopsis of the Cretaceous fossils of South Africa and description of the recent efflorescent rocks, calcareous, lateritic, and siliceous. Dr. Du Toit has given special attention to water supply, and his valuable chapter on that subject describes the interesting tidal wells at Cradock in the east-central part of Cape Colony.

The economic geology of South Africa is especially instructive. The diamonds are widely scattered, and in considering their formation the author is not unduly influenced by the Kimberley pipe. He points out that nine-tenths of the kimberlite occurrences are barren of diamonds, and it appears that at least most of those that yield diamonds contain tourmaline in addition to the mineral species proper in an ultra-basic rock. He accepts Dr. Wagner's conclusion as to the diamonds of south-west Africa, as Kaiser's monograph on that field appeared too late for consideration of its evidence for a different explanation. The most important recent contribution of South Africa to the mineral wealth of the world is that of platinum; the author gives an account of the information available as to its distribution up to the date of the completion of his manuscript. He accepts the

view that some of the platinum is a direct segregation in ultra-basic rock; but he recognises the bulk of the ore of commercial importance as a metasomatic formation, while the platinum in the quartz veins is also due to some hydrothermal agency. The Transvaal has not yet had any important output of platinum; but the prospecting work encourages the hope that the South African yield will materially reduce the price of that useful metal.

J. W. GREGORY.

Plants and People of South-west China.

Naturbilder aus Südwest-China: Erlebnisse und Eindrücke eines österreichischen Forschers während des Weltkrieges. Von Dr. Heinrich Handel-Mazzetti. Pp. xiv + 380 + 77 Tafeln. (Wien und Leipzig: Österreichischer Bundesverlag für Unterricht, Wissenschaft und Kunst, 1927.) 24 gold marks.

UNDER the auspices of the Academy of Sciences, Vienna, Dr. Handel-Mazzetti, the well-known Austrian botanist, made extensive explorations in south-west China during the years 1914-1918; and this handsome volume is a popular account of the scientific results of these travels. The book is remarkable for the wealth and beauty of the illustrations, which are reproductions of photographs, a considerable proportion being autochromes, that depict the scenery and vegetation in their natural colours. It is the first time that we have had an opportunity of seeing pictures of the wild habitats of many beautiful plants that have been recently introduced into our gardens from China. The book makes, accordingly, a strong appeal to horticulturists; and we hope that a translation into English will soon be published.

Compelled by the outbreak of the War to remain in China for nearly five years, Dr. Handel-Mazzetti explored with great zeal one of the richest floral regions in the world. During the first three years, 1914-1916, he travelled to and fro across the high plateau of western Yunnan, and made numerous ascents of the lofty peaks and ranges on the boundary adjoining Tibet. He crossed and re-crossed the deep gorges of the Yangtze, Mekong, Salween, and Irrawaddy, where these four great rivers, flowing parallel in a narrow space (lat. 27°-28°), form perhaps the wildest and most romantic scenery on the face of the globe. Overcoming incredible difficulties with limited resources, he amassed a vast collection of botanical specimens, and took numerous photographs and observations

illustrating the topography, geology, and ethnology of the region.

During 1914, Dr. Handel-Mazzetti went northward into the province of Szechwan, and penetrated into Ta Liang Shan, the secluded kingdom of the Independent or Black Lolos, an interesting aboriginal race, to whom he devotes a chapter of description and several pictures. Scattered through the book are notes and illustrations of many other peculiar peoples—Moso, Nahsi, Lissu, Miao, and various Tibetan tribes. An attractive autochrome (Pl. 36) represents the Moso village of Kua-pi, the seat of an hereditary chief.

Special attention is paid to plant ecology, all the different formations being described and illustrated. We may quote as an example Pl. 39, which represents in colour a mountain meadow at 11,000 feet altitude, gay with flowers of *Primula*, *Pedicularis*, *Trollius*, and *Anemone*. The most characteristic genus of woody plants is *Rhododendron*, of which more than 300 species have been distinguished in China. Twenty of these are shown in their natural surroundings.

Of herbaceous plants, *Primula* is perhaps the genus richest in species; and Pl. 110 shows one of the most beautiful of these, *P. calliantha*, growing at 14,000 feet elevation. Of the orchids, *Cypripedium ebracteatum*, depicted in colour in Pl. 76, is most remarkable. Other showy flowering plants, figured in their native habitat, are the giant gentian, *G. stylophora*, shown in Pl. 50, and *Lilium giganteum*, Pl. 104, which are common in open glades of the mountain forests.

Conifers constitute the mass of the forests at high altitudes in western China, and are rich in indigenous species. Dr. Handel-Mazzetti's discovery of the rare Formosan genus, *Taiwania*, in the gorges of the Salween River, is a notable achievement. He also found the so-called 'arbor-vitæ,' *Thuja orientalis*, forming woods in the valley of the Mekong. This tree, commonly planted around temples and in cemeteries throughout China, has been supposed until now to be a native of the Peking mountains; but its occurrence in the wild state in southern China suggests that it has been carried from there northwards and distributed by Buddhist priests.

In 1917, Dr. Handel-Mazzetti left Yunnan and travelled eastward across the province of Kweichow into southern Hunan, ultimately reaching Changsha, the capital of the latter province. Here he remained for some time exploring the mountains to the westward, but under great difficulties, as the Chinese were at the moment in a state of civil war.

The account of his explorations in Kweichow and Hunan, where he broke new ground, are of great interest; and the illustrations show wonderful scenery and rich vegetation. He left Changsha for Shanghai on Feb. 26, 1918, and this date marks the end of a succession of perilous journeys in the cause of science.

A. HENRY.

Our Bookshelf.

Classified Problems in Chemistry. By D. B. Briggs. Pp. viii + 152. (London: Sidgwick and Jackson, Ltd., 1926.) 3s. 6d.

THE author has made a praiseworthy attempt to provide a number of numerical problems in chemistry, arranged in methodical order for use in schools. Many of the examples are taken from examination papers of British universities, the Civil Service, and other authorities, quite a number being culled from Cambridge Tripos papers. The arrangement of chapters and sections is excellent, but the explanatory notes might have been expanded, since they will scarcely suffice for the solution of all the problems. Instead of four pages of notes on the use of logarithms, a section might have been included dealing with limits of error and accuracy, a stumbling-block to many beginners. The method of calculation on p. 24 is admirable, but in dealing with volumetric analysis it would have been better to explain the use of equivalent weights, the dependence of equivalents on the reaction studied, and the effect of any change in the equivalent weight of a compound. Experience has shown that many pupils on leaving school have failed to grasp the simplicity of this method of calculation, and until it is generally adopted, volumetric analysis will appear to be more difficult than it is.

A number of inaccuracies have been detected; for example, in question 10, p. 31, the molecular weight of ammonia can not be deduced from the data, nor can the atomic weight of the metal be found accurately in question 12, p. 47. The weight of potassium chlorate in question 22, p. 78, is not 1.08 grams, and the percentage of silver in question 44 on p. 134 is incorrect. Teachers will nevertheless find the book most useful.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Editorial Board: Henry Gilman, Editor-in-Chief, Roger Adams, H. T. Clarke, J. B. Conant, C. S. Marvel, Frank C. Whitmore. Vol. 6. Pp. vii + 120. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 7s. 6d. net.

THE preceding volumes of this series have been reviewed in these columns and are well known to most chemists. The present volume is in every respect similar. Some of the syntheses described are likely to be of use to research workers in the preparation of their starting materials, such as the syntheses of acrolein, benzil, octanol, and hexanol,

but others are more of the nature of students' preparations. The reviewer himself has tested the synthesis of acrolein given, and found that the notes simplify the process considerably and that the yields quoted can easily be reproduced. The volume also contains the recent references in the current literature relating to syntheses published in the previous volumes, and the policy is adhered to of repeating syntheses when improved methods have been afterwards described, e.g. benzil. While these volumes serve a very good purpose, it is a great pity that the price charged should be so large. As it would ultimately be best to have the volumes bound together, it would be a good plan if a cheaper edition were published with less elaborate bindings.

A Manual of Navaho Grammar. Arranged by Fr. Berard Haile. Pp. xi + 324. (St. Michaels, Arizona: Franciscan Fathers, 1926.) 6 dollars.

THIS study of Navaho grammar, which it may be said is a very thorough piece of work, might well be recommended not only to the student of the linguistics of the North American Indian, but also to those who are interested specifically in his psychology. The chief grammatical devices for the expression of ideas in Navaho are the noun and the verb. Of these the verb is of special importance in this connexion, as it most markedly brings out the distinctive point of view of the Indian mind, which emphasises minute detail in relation to perceptible things. These are described with infantile accuracy. The verb structure therefore gives expression to the attention which the Indian pays to size, shape, form, directional position, and like qualities of the subject. A great deal of work is thus thrown on the verb by means of adverbial prefixes and suffices. In Father Haile's arrangement of the grammar, careful attention has been given to this aspect as well as to the verb stem. Notwithstanding a considerable amount of research along this line, the author acknowledges that much still has to be done.

Exploring England: an Introduction to Nature-craft. By Charles S. Bayne. Pp. 216 + 16 plates. (London: Jarrolds Publishers London, Ltd., n.d.) 7s. 6d. net.

THE 'exploring' of this work is the exploration of the naturalist in the familiar places of the country-side, and 'England' need scarcely have limited the study, for with few exceptions the creatures described occur throughout the British Isles, while at least one of them, the crested tit, is confined to Scotland, and others, like the dotterel and the grey lag-goose, are mentioned only in connexion with their nesting there. In turn the author visits the hedgerows, the woods, the streams and marshes, the coast, and so on, and describes the plants and animals which are likely to be found in each type of area. There are many shrewd observations on the habits of wild creatures, but the descriptions and illustrations are insufficient in many cases to guide the novice to the identity of his quarry, and that is a first essential in nature-craft.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Hardness of Alloys.

IN continuation of my note on the hardness of metals in NATURE of Feb. 19, I now subjoin diagrams showing the variation of hardness which occur in certain alloys of copper with the percentage of the alloying metal (Fig. 1).

The alloys were prepared by melting, in a quartz test-tube and in an atmosphere of hydrogen or coal gas, the proper proportions of the constituent. When melted these were stirred by shaking the tube, which was then allowed to cool. This left the alloy in the form of a 'button,' from which the test-pieces were cut. No hammering or any kind of work other than that required to file or grind them to a conical shape was used in their preparation; all the hardnesses indicated in the diagrams therefore refer to cast metal.

In these diagrams the ordinates give the hardness in tons per square inch, the abscissæ being the volume percentage of the alloying metal, that is, so much per cent. of the volume consists of the alloying metal and the rest of copper.

In every case, except that of bismuth, there is a certain amount of hardening as the percentage of alloying metal increases to something like 30 per cent., and in general the alloy becomes brittle near the point of maximum hardness.

To determine the ordinates of the 'hardness' curves, eight alloys were prepared for each of the metals used (or ten if pure metal at each end of the percentage scale is included), and though the brittle specimens were difficult to deal with, I believe that the result gives a fair representation of the facts.

Some of the alloys, notably those containing tin and antimony, though not hard, could not be cut

pressures as exist at the cutting edges of the saw teeth and at the point of the conical test-pieces.

The measures were made by the apparatus sketched in Fig. 2. A platform mounted on rollers carries a

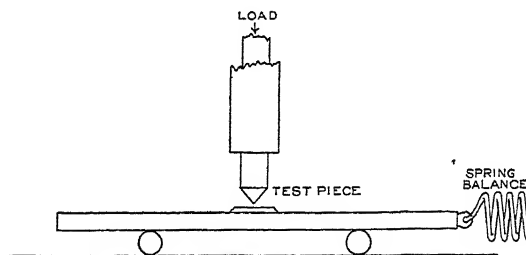


FIG. 2.

polished plate of some hard material, on which the loaded test-piece presses. A lateral force is

COEFFICIENTS OF FRICTION UNDER HIGH PRESSURE.

	Coefficients of Friction.	Pressure. Tons per square inch.
Steel on Glass . . . dry	0.12	111.0
" " . . . in water	0.125	110.0
" " . . . in oil	0.12	110.0
" on Sapphire . . . dry	0.1	117.0
" " . . . in water	0.101	117.0
" " . . . in oil	0.114	117.0
Pure Copper on Sapphire . . . dry	0.100	20.0
Pure Cadmium on Sapphire . . . dry	0.1	2.3
Pure Tin on Sapphire . . . dry	0.124	0.22
Copper Alloy 20 % Zinc on Sapphire . . . dry	0.100	32.0
" " 28 % Tin on Sapphire . . . dry	0.084	68.0
" " 40 % Tin on Sapphire . . . dry	0.085	16
" " 40 % Tin on Steel . . . dry	0.090	16
" " 15 % Bismuth on Steel . . . dry	0.092	5.8
" " 15 % Bismuth on Sapphire . . . dry	0.092	3.7
" " 20 % Antimony on Sapphire . . . dry	0.094	5.2

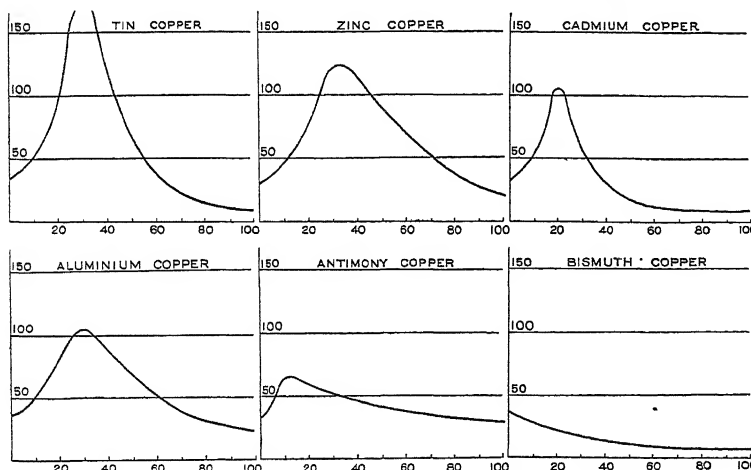


FIG. 1.—Hardness of alloys of copper. Ordinates give hardness in tons per sq. in. abscissæ give volume percentage of alloying metal.

with a saw, the saw refusing to bite when applied with a light pressure, and splintering the metal when the pressure was increased.

It seemed worth while, therefore, to measure the coefficient of friction of the alloys under such high

applied to the platform by a spring balance, and the reading of this balance when the force is just sufficient to cause the hard surface to slip under the point is noted.

The Table above gives samples of the result obtained. When the plates were well polished the balance readings were very consistent, and the force required to cause 'slip' was closely proportional to the load on the test-piece.

It appears that with these high pressures, lubrication has no practical effect, the lubricant, I suppose, being completely squeezed out.

It appears also that for pressures of the order employed, the pressure itself is a matter of indifference, the important factors being the nature of the materials and the product of the area of contact and the pressure, i.e. the load. It would occupy too much space to give the details of these experiments, which I hope to repeat with a more convenient form of apparatus.

A. MALLOCK.

9 Baring Crescent, Exeter.

The Theory of the Paramagnetism of Oxygen and Nitric Oxide.

THE two important paramagnetic gases are oxygen and nitric oxide, and to account numerically for their susceptibilities has long been a puzzle. The new quantum mechanics, together with recent spectroscopic data for nitric oxide, seem at last to solve the difficulties.

Sommerfeld ("Atombau," p. 641) has shown that the susceptibility of oxygen can be explained by assuming that, despite the presence of two nuclei, the magnetic behaviour of the O_2 molecule is like that of an atom in a 3S state. This apparently involves the unreasonable hypothesis that the angular momentum responsible for the magnetic moment is directly quantised relative to the magnetic field rather than relative to the rest of the molecule. In S states the angular momentum, to be sure, arises entirely from internal spins, and spin axes are more loosely coupled than the orbits themselves. Even so, however, the internal forces doubtless ordinarily (except in highly excited states) predominate over the external field; for the latter can, in fact, be made as small as we

The solution of this dilemma is, I believe, found in a very general derivation I am publishing elsewhere (*Phys. Rev.*, May 1927) of the Langevin formula $N\mu^2/3kT$ for the susceptibility χ . This proof uses the new quantum mechanics and supposes only that the molecule have a 'permanent' moment μ , and that the separation between component energy levels of the normal state be small compared to kT . This condition is doubtless fulfilled in O_2 , for frequencies of nuclear rotation are ordinarily small compared to kT/h , and the superposed precession of the spin axis is much slower in S than in P or D states because of the vanishing orbital angular momentum. If μ arises entirely from spin moment, then by the new mechanics we get $\mu^2 = 4s(s+1)M^2$, where M is the Bohr magneton $he/4\pi mc$ and $s = 1/2$ for doublet terms, $s = 1$ for triplets, etc., thus giving agreement with Sommerfeld's susceptibility formula for atomic S terms. There is now, however, nothing in the proof to prevent the spin axis being quantised either (a) relative to the axis of figure or (b) relative to the axis of temperature rotation (Hund's classification), or even from being coupled in a manner intermediate between (a) and (b).

The case of nitric oxide is particularly interesting. The spectroscopic data of Jenkins, Barton, and Mulliken (*NATURE*, 119, 118; 1927) and others, show that the normal state of nitric oxide is a 2P doublet. The upper and lower components have respectively $\sigma = 3/2, 1/2$, and are separated by 122 cm^{-1} . Here σ is the angular momentum about the axis of figure, measured in multiples of the quantum unit $h/2\pi$, and equals $\sigma_k + \sigma_s$, where $\sigma_k = 1$ is the component of orbital angular momentum along this axis, and $\sigma_s = \pm \frac{1}{2}$ is the corresponding component for the spin angular momentum. Because the spins have twice the normal ratio of magnetic moment to angular momentum, the upper and lower components therefore have respectively magnetic moments $2M$ and 0 along the axis of figure. Calculations of the susceptibility for a mixture of molecules with two and zero Bohr magnetons, with relative abundance determined by the Boltzmann temperature factor, do not, however, agree with experiment. This failure is due to neglect of the component of spin magnetic moment perpendicular to the axis of figure. We may, on the other hand, disregard the perpendicular component of orbital moment, as this doubtless precesses very rapidly. If the precession frequency $\Delta\nu$ of the spin axis about the axis of figure were small compared

to kT/h , we could simply take $\mu^2/M^2 = \sigma_k^2 + 4s(s+1) = 4$ in the derivation of the Langevin formula cited above. Actually $\Delta\nu$ is 122c, and so special calculations with the new mechanics are necessary, which yield

$$\chi = \frac{4NM^2}{3kT} \cdot \frac{1 + (x-1)e^{-x}}{x(1+e^{-x})}$$

where $x = h\Delta\nu/kT$. This gives a susceptibility at room temperatures corresponding to 9.12 Weiss magnetons, which agrees excellently with Bauer and Piccard's experimental value 9.20. The hope of Jenkins, Barton, and Mulliken that their spectroscopic data would permit the quantitative calculation of susceptibility is thus fulfilled. Details of the computations will be published elsewhere.

J. H. VAN VLECK.

University of Minnesota.

Influence of Carbon Monoxide and Light on Indophenol Oxidase of Yeast Cells.

WARBURG (*Biochem. Zeitschr.* 177: 1926) has shown recently that carbon monoxide at a high partial pressure inhibits the respiration of yeast and cocci cells. He also found that a respiratory substance involved in this process has a much higher affinity for oxygen than for carbon monoxide, and that the carbon monoxide compound of this substance is dissociated by the visible rays of light.

Warburg's results as to the inhibition of respiration by carbon monoxide have been extended by Haldane (*NATURE*, 119, 352; 1927) to the wax-moth and cress plants.

The main object of my study was to localise the action of carbon monoxide, and to find whether the substance influenced by it has any connexion with the known respiratory substances.

Cytochrome, which is present in yeast cells, does not combine with carbon monoxide. The ordinary (unbound) hæmatin which is also present in yeast cells has, on the contrary, a much greater affinity for carbon monoxide than for oxygen, and, when reduced, it combines, even at a very low partial pressure, with carbon monoxide. Thus, none of the four different iron-porphyrin compounds of living yeast cells is responsible for the phenomenon discovered by Warburg.

In addition to hæmatin compounds, yeast cells contain a polyphenol oxidase which can be demonstrated when the reducing power of the cells is inhibited by urethane, cooling on ice, or heating yeast suspension (in phosphates at pH 7.3) to $50^\circ\text{--}52^\circ\text{C}$., and keeping it at that temperature for an hour. 2 c.c. of a 5 per cent. suspension of baker's yeast heated to 50°C . gives a strong reaction with 0.5 c.c. of 'Nadi' mixture composed of equal parts of 0.01 M. dimethyl-para-phenylenediamine hydrochloride in 50 per cent. alcohol, 0.01 M. alpha-naphthol in 50 per cent. alcohol, and 0.1 per cent. sodium carbonate in water.

The indophenol reaction of yeast is inhibited by boiling, by potassium cyanide and by carbon monoxide. The influence of carbon monoxide can be demonstrated in the following manner: 2 c.c. of the above yeast suspension is put in each of six slightly modified Thunberg's vacuum tubes and 0.5 c.c. of 'Nadi' reagent added into the bent portion of their hollow stoppers. These tubes, standing in the same rack, are filled with various gas mixtures; they are then reversed, the yeast suspension being mixed with 'Nadi' reagent, shaken for 1.5 minutes in the dark, and examined. The following are the results of such an experiment:

Tubes.	O ₂ %.	CO %.	N ₂ %.	Reaction.
1	7.32	63.4	29.28	XX
2	5.22	73.9	20.8	X
3	3.6	82.0	14.4	0
4	3.4	0	96.6	XXXX
5	1.8	0	98.2	XXX
6	1.1	0	99.0	XX

Similar results are obtained with yeast in which the respiration is almost completely abolished, while the oxidase is still very active.

Daylight, or the light of a $\frac{1}{2}$ watt electric lamp (50 c.p.), dissociates the carbon monoxide oxidase compound, the oxidase becoming active again. To demonstrate this, six Thunberg's tubes are prepared as in the above experiments, evacuated to about 150 mm. to 200 mm. pressure of mercury, and are filled with pure carbon monoxide. These tubes, standing in the same rack, are then reversed and their contents mixed in the dark. Of the six tubes, three are covered and kept dark, while the other three are exposed to the light by shaking the rack in front of an electric lamp. After shaking for 1.5 minutes, the three protected tubes are uncovered, and the reaction in all six tubes is compared rapidly. The result is that, while the three tubes kept in dark show only a slight blueing (X), the tubes exposed to the light show a strong blue colour of indophenol (XXXX). Control experiments with tubes filled with nitrogen instead of carbon monoxide show no difference in the rate of indophenol formation in the tubes exposed to the light or kept in the dark.

Carbon monoxide was found to inhibit in a similar manner the indophenol oxidase of mammalian muscles, and the oxidation of catechol by the aqueous extract of oatmeal flour or of dry potato oxidase preparation.

These experiments show that Warburg's respiratory ferment is a polyphenol or indophenol oxidase system, which can display its characteristic reactions even in dead cells in which the respiration is abolished. All this clearly indicates that the oxidase systems revealed by the indophenol test belong to respiratory catalysts essential for the oxygen uptake by the living yeast cell.

D. KEILIN.

Molteno Institute.

University of Cambridge.

The Industrial Revolution.

I AM curious to learn the grounds upon which Miss Buer (See NATURE, Mar. 12, p. 379) bases her belief that the rise of population in England after 1750 was due to the introduction of the practice of inoculation and a consequent decline in infant mortality.

The accepted view is, I believe, that the rise was due in the first instance to the expansion of England's colonial trade, which increased twelve-fold, according to Edmund Burke, between 1702 and 1772. The growth of the demand for English cloth led to Kay's invention of the fly-shuttle in 1733. This invention doubled the weavers' output, raised the prices of yarn, and thus gave increased employment in the spinning trade.

Newcomen's steam-engine was introduced in 1712, and thenceforward made steady progress, resulting in an increased demand for coal. The new conditions inaugurated by the growth of trade and invention reacted upon agriculture and transport, and thus paved the way for the Industrial Revolution.

It is difficult to see how medical science could affect the size of a population. Unless there is more to

divide, population cannot increase. Moreover, under the conditions prevailing in the eighteenth century a high rate of infant mortality would not affect the size of the population. Natural fertility would secure a replacement of the infant population. *Primo avulso non defuit alter.*

E. WYNDHAM HULME.

Littlehampton.

I SHOULD like to reply briefly to the points raised in Mr. Wyndham Hulme's letter. In my book I have laid considerable stress on the growth of commerce and its important reaction upon agriculture and consequently upon population. My reviewer has also mentioned this, though naturally stressing other points of more immediate interest to readers of NATURE.

In regard to Newcomen's engine; its use was never widespread, and, after experiment, was frequently abandoned owing to the wasteful consumption of fuel. Water-power was always preferred when available. The growth of the coal trade before 1800 was mainly due to the increasing use of coal for domestic purposes and for brewing, brick-making, forging, smelting, etc., rather than to the demands of the steam-engine. This increasing use of coal was partly due to the growing shortage of timber and partly to the development of canals.

In regard to the statement that "Unless there is more to divide, population cannot increase," from one aspect this is a truism, but Mr. Hulme seems to imply by it that production cannot be adjusted to needs. This implication is open to question. Given a sufficiently elastic social system, a growing population will stimulate production, and it undoubtedly did so in the period in question.

Neither can I agree that a high rate of infant mortality does not affect the size of a population, because the birth-rate adjusts itself to this rate. Obviously, this argument cannot hold if the birth-rate is at the maximum which natural fertility allows. The nearer the actual birth-rate is to this maximum the smaller is the possible movement of the birth-rate in an upward direction. Personally, I believe that until recent times, when the use of contraceptives introduces a new factor, the death-rate rather than the birth-rate was the prime regulator of population. In regard to the period under review, there is no evidence of any appreciable alteration of the birth-rate, but there is overwhelming evidence of a great fall in the death-rate, mainly among infants, and this fall was concomitant with a great growth of population. The fall of the death-rate was due to a variety of causes, of which inoculation was probably one. For the grounds upon which I base my conclusions I can only refer Mr. Hulme to my book, in which they are stated in some detail.

MABEL C. BUER.

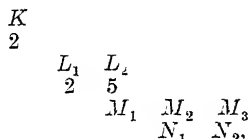
The University,
Reading.

Regularity in the Spectrum of Ionised Neon.

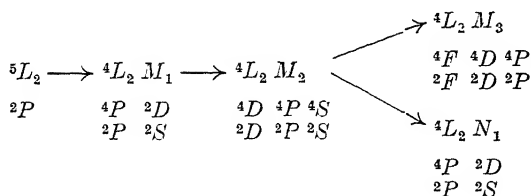
THE spectrum of neon has been completely analysed by Paschen, but certain lines were obtained by Liveing and Dewar in 1900, and afterwards confirmed by Merton (*Proc. Roy. Soc.*, vol. 89, p. 447), which are not included in Paschen's scheme. L. and E. Bloch and Dejardin (*J. de Phys.*, May 1926) obtained these lines by the method of electron bombardment, and found that the lines come out strongly at 49 volts. They ascribed the lines to ionised neon.

I have tried to classify these lines, and have succeeded in arranging about 140 of them in groups of

multiplets. Taking the structure diagram of neon, namely,



it is found that the expected terms and combinations are as follows :



I have obtained combinations which are combinations between ${}^4L_2 M_2$ and (${}^4L_2 M_3$, ${}^4L_2 N_1$)-terms. Two multiplets are shown below :

	4P_1	4P_2	4P_3
4P_1	36082.3 (1)	36264.8 (3)	
4P_2	35777.6 (3)	35960.0 (2)	36182.3 (2)
4P_3		35582.9 (4)	35805.5 (4)
4D_1	32825.2 (3)	33006.0 (4)	
4D_2	32726.9 (5)	32909.5 (3)	33131.9 (3)
4D_3		32803.6 (6)	33025.7 (4)
4D_4			32944.9 (5)

A complete analysis will shortly be published.
P. K. KICHLU.

Physics Department,
University of Allahabad.
India, Mar. 3.

Herbert Spencer's Electrical Apparatus.

It may be of interest to record the fact that the electrical apparatus formerly owned by Herbert Spencer, consisting of a cylinder machine, three Leyden jars, an insulated stand and plates, with other accessories, which include an electrical pistol, is still in existence. One of the smaller pieces of apparatus bears the name G. Adams, London, who was presumably the maker, and the whole is contained in a wooden box.

The apparatus belonged originally to Herbert Spencer's father, William George Spencer, usually known as George Spencer, who kept a school in Derby and was for many years secretary of the Derby Philosophical Society founded by Erasmus Darwin. It was his practice to show electrical experiments to his pupils and at the meetings of the Society. Herbert Spencer in his autobiography says: "My father had an electrical machine and an air-pump, and from time to time classes of his pupils came to see pneumatic and electrical phenomena. I had frequently to make preparation for the experiments and aid in the performance of them. The result was that being on

many occasions witness to the facts, and hearing the explanations given, I early gained some knowledge of physics. Incidentally I was led into Chemistry. One of my duties in preparing for these lectures was that of making hydrogen to fill the electrical pistol."

The history of the apparatus is well-authenticated. Herbert Spencer's mother died in 1867, and shortly afterwards he gave up the Derby house and distributed most of the contents. In the autobiography he says: "Soon after my mother's death I therefore arranged to give up the house. Reserving valued relics and such few pieces of furniture as promised to be useful in London, and distributing the rest among my relations, I surrendered the key to the landlord."

It was at this time, or shortly afterwards, that Herbert Spencer gave the electrical apparatus to George Holme, who as a youth of sixteen or seventeen had saved him from drowning and had been his friend ever since. George Holme afterwards became a well-to-do manufacturer and was Mayor of Derby in 1875. An edition of Spencer's works was inscribed: "From Herbert Spencer to his old friend George Holme, without whose courageous aid rendered in boyhood neither this work nor any of the accompanying works would ever have existed." On the death of George Holme the apparatus was left to his grandson, George Hyde. At his death his widow gave it to their nephew, Mr. Colin Hyde Bennett, the present owner, whose parents still live in Derby. It is to their courtesy that the present writer owes the opportunity of inspecting the apparatus, as well as the supreme satisfaction of firing the electrical pistol, which shot its cork vigorously across the room.

FREDK. W. SHURLOCK.

6 Glenhouse Road,
Eltham, S.E.9,
April 14.

Convection of Heat in Fluid Flow through Pipes.

IN his letter in NATURE of April 9, p. 527, Mr. H. F. P. Purday proposes to add yet another purely empirical formula to the many already proposed for representing the transfer of heat from a tube to a fluid passing through it. I cannot believe that much progress is possible along this line. Any further advance must, I think, be based on physical considerations, which will indicate the form of the functions involved, as to which the theory of dimensions can give us no information whatever.

It is now, I think, generally agreed, that in the turbulent flow of a fluid through a pipe there is always a layer which creeps in viscous or laminar flow along the surface of the tube, whilst the remainder of the cross-section of the tube is filled with turbulent fluid. Osborne Reynolds, many years ago, gave a rational expression for the transfer of heat from the interior surface of the viscous layer to the turbulent core. Across the viscous layer, heat transfer can only take place by conduction. If we knew its thickness we could find a complete expression for the transfer of heat from the hot wall to the fluid. Such an expression must necessarily involve at least two terms, since the transfer is effected in part by conduction and in part by convection.

Whilst it does not seem possible to calculate directly the thickness of the laminar film, it is possible from physical considerations to fix an upper limit to its maximum possible thickness. The actual thickness must be less than this, so that if the limiting thickness be found, as above indicated, the actual thickness will be ϕt , where t is the limiting thickness and ϕ a coefficient to be determined by

experiment, and which has, it will be seen, a definite physical signification.

To my surprise, an examination of the experimental data indicated that ϕ was sensibly constant, the figure found being 0.55. I fully expected that ϕ would increase as the critical velocity was approached; but the experimental evidence did not bear this out.

Incidentally, I was able to show that when the fluid traversing the tube was water, which in practice always contains dissolved gases, there was a second 'critical' condition besides that corresponding to the critical velocity. Up to a temperature of about 80° C., gases are but slowly liberated from water: but if the pressure be atmospheric, they come off freely if this temperature be exceeded. This results in the breaking up of the laminar film, and there is then, as experiment shows, a sudden and large reduction in the resistance to heat transfer when the wall temperature rises above some 80° C.

The complete research was published in *Engineering* of July 6, 1923, *et seq.* H. M. MARTIN.

26 Addiscombe Road,
Croydon.

The Anomalous Flocculation of Clay.

THIS is a rather belated reply to Prof. Comber's letter to NATURE of Sept. 18, 1926 (vol. 118, p. 412), but we should like to refer to one or two points. It is a little difficult to be sure of what Prof. Comber means by the statement that "Flocculation of clay by calcium salts is anomalous when considered in the light of prevalent theories," when, perhaps, no theories on this question can be said to be prevalent. With regard to the facts (on which the theories ought to be based) we profess to have established the following:

(1) Clay flocculated by dilute hydrochloric acid and then purified from electrolytes by dialysis or other means is nearly free from exchangeable bases.

(2) Such clay (containing only 0.1 per cent. of replaceable calcium) is readily flocculated by sodium hydroxide: this seems in direct conflict with the last paragraph of Prof. Comber's letter. Further, kaolin and pure silica containing no exchangeable calcium can be readily flocculated by sodium hydroxide.

(3) It is more easily flocculated by the chlorides than by the hydroxides of either sodium or calcium where the concentration of the base does not exceed 0.5 N and 0.002 N respectively.

(4) At higher concentrations it is more easily flocculated by hydroxides than chlorides, and this is true both for sodium and for calcium.

(5) In the case of suspensions of pure silica containing only particles less than 2μ diameter, flocculation cannot be brought about by the chlorides at concentrations up to normal, whilst in the case of the hydroxides, N/60 and N/10 are sufficient for calcium and sodium respectively to produce flocculation in one hour.

(6) The flocculation of silica differs from that of clay in that the former is only flocculated by sodium or calcium chloride in an alkaline medium. The concentration required decreases with increasing alkalinity, and this also holds for clay above a pH of about 9. If, however, a small amount of aluminium hydroxide is precipitated on the silica, there results an electro-negative suspension of which the behaviour towards flocculants is remarkably similar to that of clay. In particular, it shows the phenomenon of successive flocculation, deflocculation, and flocculation on the addition of increasing quantities of alkaline

solutions of sodium chloride, as described in the case of clay in our previous letter to NATURE (May 1, 1926, p. 624).

These are the facts so far as we have gone: silica and clay are certainly different in respect to flocculation phenomenon, but it is better not to call either anomalous.

A. F. JOSEPH.

H. B. OAKLEY.

Wellcome Tropical Research Laboratory,
Khartoum, Mar. 15.

The Financing of Research Associations.

MANY of the industrial research associations of Great Britain have, in the opinion of the leaders in their respective industries, amply justified their existence. In view of the possible cessation of their State subsidy, these associations must consider means for raising revenue adequate for their continuance on a permanent basis.

The present method of soliciting annual donations from firms and trade associations leaves a research association in a recurring state of financial uncertainty which makes it difficult to plan any extensive or expensive research. The refusal of some firms in the industry to co-operate is a further handicap.

In the case of some associations, the time is ripe for ascertaining the amount of support likely to be provided from the industry itself and from the users of its products. I include the users because it often happens that they reap much of the financial benefit arising from the work of the association, as, for example, when this work results in the improved efficiency of electrical generating or distributing plant.

In industries in which a desire exists for the continuance of their research associations after the expiry of the subsidy, it would be necessary to estimate the amount needed to place the work on a satisfactory basis, and to ensure that this amount can be secured, as a minimum, for, say, ten years. It seems reasonable to ask the firms interested to agree to a voluntary levy of a small percentage of the turnover of each of them. In some industries one pound for each thousand pounds of turnover would provide sufficient revenue, provided the scheme were widely supported. No firm need disclose the amount of its turnover except, in confidence, to a chartered accountant.

Such a scheme for placing the finance of the associations on a more permanent basis is not likely to be approved by the financial heads of firms without pressure from those concerned in the continuance of co-operative research: the purpose of this letter is to impress on those readers of NATURE so concerned the advisability of considering the advantages and difficulties of such a scheme, and, if approved, of pressing it on the notice of those who would need to be influenced to subscribe.

ROBT. W. PAUL.

Surface Film of Aluminium.

It is generally believed that the surface of aluminium is normally covered with a thin layer of aluminium oxide or hydroxide, and that the metal possesses the property of forming this film on freshly cleaned surfaces. Bengough and Hudson (*Jour. Inst. Metals*, 21, p. 143) state, "the metal is normally covered with a layer of oxide," and Seligman and Williams (*Jour. Inst. Metals*, 23, p. 169), "It is generally assumed that aluminium exposed to air is covered by a film of oxide or hydroxide which prevents

the complete oxidation of the metal. The film is invisible and, so far as the writers are aware, no direct evidence of its existence on aluminium ordinarily treated has been adduced."

Until very recently we were in agreement with Seligman and Williams regarding the absence of direct evidence. During the course of experiments made with the object of studying the properties of films produced on aluminium by the Bengough anodic process, we found it was possible to isolate the films by the following method:

The aluminium, preferably in the form of thin sheet, is cut into narrow strips, and one or more of these strips is heated in a tube in an atmosphere of dry hydrogen to a temperature of 300° C. Dry hydrogen chloride is then passed through the tube. The metallic aluminium exposed at the cut edges of the strips reacts with the hydrogen chloride to form aluminium chloride, which sublimes and deposits in the cooler parts of the tube. Ultimately all the metallic aluminium is so removed and the surface films remain, together with some of the impurities in the aluminium.

By the above method it was found possible to obtain a film from normal commercial aluminium sheet. The natural film liberated in this way was extremely delicate, tended to curl, and was small in amount, but appeared to be continuous.

H. SUTTON.

J. W. W. WILLSTROP.

Royal Aircraft Establishment,
South Farnborough, Hants,
April 7.

Formation of Organic Acids from Sugars by *Aspergillus niger*.

UNDER the above title we recently showed (*J. Chem. Soc.*, 1927, 200) that when *Aspergillus niger* is grown on citric acid as sole source of carbon, the formation of acetone, malonic acid, and glyoxylic acid can be demonstrated. The production of citric acid from potassium saccharate and the mould may be detected, under careful control, by Denigés' test and by oxidation to acetone. It appears, therefore, that saccharic acid may possibly be an intermediate product in the formation of citric acid from glucose by *Aspergillus niger*, as was suggested by Franzen and Schmitt in the case of the citric acid in plants (*Berichte Deutschen Chem. Ges.*, 1925, 58, 222).

This view has now received further support from our recent observation that when *A. niger* is grown on glucose as sole source of carbon, the solution contains saccharic acid, which may be isolated as the potassium hydrogen salt. This has been identified (1) by titration with standard alkali, (2) by determination of potassium, and (3) by determination of thallium in the corresponding thallium hydrogen salt. Apart from the observation of Grüss (*Jahrbücher für wiss. Botanik*, 1926, 66, 155, 171, 177) that saccharic acid is formed by the action of the yeasts *Anthomyces Reukauffii* and *Amphiernia rubra* on glucose, this would appear to be the only recorded instance of the production of this acid by micro-organisms.

Grüss employed a medium containing glucose and traces of peptone, asparagine, potassium tartrate, and mineral salts, and the saccharic acid was identified microscopically as the calcium hydrogen salt.

F. CHALLENGER.

V. SUBRAMANIAM.

T. K. WALKER.

Municipal College of Technology
and the University,
Manchester.

No. 3001, Vol. 119]

The Supposed Law of Flame Speeds.

IN NATURE of Feb. 12, p. 238, Dr. W. Payman and Prof. R. V. Wheeler reply to my letter in the issue of Jan. 8. They agree that deviations from the law of speeds may be expected if one of the combustibles in a complex mixture interferes with the burning of another, but claim that the deviations are small.

The examples I gave were carbon monoxide—hydrogen—air, and carbon disulphide—ethyl ether—air mixtures, but similar effects are obtained when ether is replaced by any one of a large number of combustibles. With regard to the first example, I quote Dr. Payman (*Jour. Chem. Soc.*, 1919, 115, 1456): "... in the present research the maximum speed of uniform movement of flame in mixtures of carbon monoxide and air is found to be about half the value calculated, making use of the values determined for hydrogen—air and hydrogen—carbon monoxide—air mixtures." Such a difference between the calculated and experimental values would argue more than a small deviation from the law of speeds.

The same conclusion can be drawn from my own determinations of speed of flame in carbon disulphide—second combustible—air mixtures. Here the 'effective' speeds of the carbon disulphide—air mixtures, as calculated from the complex mixtures, are often less than half those directly determined. This phenomenon can scarcely be ascribed to a 'cool' flame, as it occurs even with a carbon disulphide—air mixture proportioned to give perfect combustion. An account of these experiments is being prepared for publication.

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Saltcoats.

The Origin of the Earth's Surface Structure.

SOME further explanation of certain points in our letter in NATURE of April 9 on the above subject is desirable.

Our argument concerning the mode of origin of the earth's surface structure does not turn upon whether dunite or eclogite forms the deeper substratum; for these substances differ but little in radioactivity and are alike in density. The uranium and thorium content of dunite (*Phil. Mag.*, May 1924) is considerably below that of the plateau basalts, and their content of potassium is practically nil. Hence, whether eclogite or dunite occupies the depths, we are justified in concluding that density and radioactivity vary inversely in the earth's outer regions: the intrinsic density increasing and the radioactivity diminishing downwards. If Prof. Holmes's suggestion that the lower part of the continents is dioritic in character is correct (NATURE, Oct. 23, 1926), the rule still applies. Our preference for eclogite as occupant of the depths is founded on the simplification involved, seeing that this substance is to be expected therein as a piezocrystalline form of basaltic magma; for such it undoubtedly is.

While our contention that seismic evidence is not opposed to the existence of deep-seated eclogite is true, it is also true that its presence has not as yet received the same experimental support as the presence of dunite has received. We believe the experiments of Adams and Gibson have not so far been extended to eclogite. There is much to justify the expectation that when they are so extended the results will be similar.

J. JOLY.

J. H. J. POOLE.

The Modern 'Zoo.'

ALMOST simultaneously there have been made announcements of two proposals of great importance in the evolution of the modern zoological garden in Britain. The Zoological Society of London has acquired an estate of 400 acres, lying under the Dunstable Downs, midway between Tring and Luton, which is to be developed on lines very different from those familiar in Regent's Park; and the Zoological Society of Scotland proposes to develop its park to the crest of Corstorphine Hill, over 47 acres which it now possesses but which have hitherto been used as a golf course.

of Nature, wished to see at close quarters, but in conspicuous safety, the fiercest and the rarest of animals, and the old zoos met the demand by erecting closely packed cages and stout iron bars. The public no longer sets so high store upon the cramped animal, spending a lifetime in an endless promenade of an inadequate cage, and a growing responsibility towards the animals themselves, as well as a developing artistic perception, have led to the modern ideal of surroundings approaching as closely as possible to the natural environment, in which animals may display their graces of move-



Photo]

FIG. 1.—The Polar Bear enclosure in the Scottish Zoological Park.

[J. C. W. Kechnie

In magnitude the two ventures are scarcely comparable, but both are at one in indicating that the future of zoological garden development in Great Britain lies along the lines of spaciousness and freedom, and that the old-fashioned 'zoo,' cramped in space and overstocked in kind, meeting neither the needs of the animals nor the demands of the Nature lover, is on the path to extinction.

The change marks a revolution in the attitude of the public towards captive animals during the past century. The 'zoo' fashion swept over Europe in the early half of the nineteenth century: the London Zoo in Regent's Park was founded in 1828; the Dublin garden in 1830; Clifton, Bristol, in 1835; Belle Vue, Manchester, in 1836; Amsterdam in 1838; Antwerp in 1843; and Berlin in the year following. The people, animated by a sensation-loving curiosity rather than by a love

ment and repose in the greatest permissible freedom. It is interesting to recall that the prime movers in this beneficent revolution were not the great public zoos, but the owners of private collections.

The Zoological Society of London has been fortunate in its choice of new ground. The natural slope of the Ashridge estate, rising on one side rather abruptly from the 500 ft. contour to more than 700 ft. above sea-level (and half the entire area exceeds the latter altitude), gives scope for wide outlooks and fine panoramic effects, which will add repose and nobility to their tenants. So far as possible, the natural amenities of the site will be retained, and, in place of unsightly barriers, concealed ditches and sunk fences masked by natural scenery will separate the different groups of animals. A chalk foundation affords a medium readily excavated, so that the creation of attractive

caves and shelters and dividing trenches becomes largely a matter of artistic planning and moderate expenditure.

In this handsome park the Society proposes to instal the larger and more hardy of its animals, its breeding and recuperating animals, and the majority of its duplicates. But apart from foreign imported creatures, Ashridge should become a great British sanctuary, tenanted by native birds, and exhibiting, congregated as they cannot be seen in any other part of the country, the few mammals which still exist, and those which formerly existed, in Britain. The stock in the London Zoo will benefit by reduction, and Regent's Park will become the home of a typical synopsis of the animal kingdom, and of the more delicate creatures which demand special conditions of temperature, feeding, and the like.

The proposed extension of the Scottish Zoological Park is less of an adventure in more ways than one, for since its inception in 1912 the Park has all along been developed on modern lines, and the inclusion of the remainder of its 74 acres, nearly twice the extent of the Regent's Park Zoo, is but the fulfilment of a project which the Council has had in view from the beginning. Nevertheless, it is an impressive scheme. The addition will carry the Park to the ridge of Corstorphine Hill at an altitude of 500 ft. above sea-level, and, while still retaining the southern exposure which has meant so much for the welfare of the animals, will throw open a fine northern prospect across the Firth of Forth and its islands to the hills of Fife and the Highlands of Perthshire. The ground is less

amenable to artificial treatment than the chalky subsoil of Ashridge, for the rock is hard and costly to excavate; but the gain is greater than the loss, since Nature has already carved the summit into rocky ridges and hillocks, affording sites which will exhibit at their best such mountain creatures as wild sheep, goats, chamois, and the like. On the lower ridges it is proposed to excavate dens and shelters for carnivores, and to give over a portion to native British mammals, while the pasture land will become ranges for native and foreign deer, bison, etc.

The sole obstacle to the development of this ground is a financial one. Last year the takings showed a modest surplus of £2000, and since the opening of the Park, all its surplus income, amounting to more than £10,000, has been spent in improvements which have added to the comfort of the animals and the attractiveness of the exhibits. To lay out and utilise the new ground, and to provide further improvements in some of the existing enclosures for animals, it is estimated that £25,000 will be required. Since such a sum cannot be obtained from the present income of the Park, the Council has issued an appeal for that amount, so that the Park may become a "National Institution, unrivalled for beauty of site and natural amenity." In furtherance of the scheme, it is announced that a mid-summer carnival and fête will be held in the Park in June. The conspicuous success already attained in the development of a modern zoological park in Edinburgh indicates that the new effort of the Zoological Society of Scotland is worthy of all support.

The Theory of Strong Electrolytes.

THE general discussion on "The Theory of Strong Electrolytes," organised by the Faraday Society at Oxford on April 22 and 23, was rendered noteworthy by the foreign guests who were able to attend and to take part in the proceedings: Bjerrum, Brönsted, and Christianssen from Copenhagen, Fajans from Munich, Hevesy from Freiburg, Hückel (a former colleague of Debye) from Göttingen, Onsager (a present colleague of Debye) from Zurich, Remy from Hamburg, and Ulich (a colleague of Walden) from Rostock, represented the European universities, whilst America was represented by Harned from the University of Pennsylvania and Scatchard from the Massachusetts Institute of Technology. The delegates enjoyed the hospitality of Exeter, Jesus, and Lincoln Colleges, and the informal discussions carried on there were not the least valuable features of the meeting.

It is now forty years since Arrhenius effected a far-reaching change in the theory of aqueous solutions by introducing the conception of electrolytic dissociation, and there can be little doubt that similar importance attaches to the recent development, by Milner, and more recently by Debye and Hückel, of theories based upon the conception of 'complete ionisation' of electrolytes. This conception, although devised in the

first instance to explain the behaviour of electrolytes in solution, has received important support from the study of crystalline salts, which has shown that most of them can be pictured as aggregates of oppositely charged ions, in which individual molecules cannot be detected, as well as from the electronic theory of valency, which has provided an explanation of the inability of these ions to effect the transfer of electrons which would convert them into neutral molecules.

The chief weakness of Arrhenius's theory lay in the fact that, although the dissociation of weak electrolytes on dilution with water was in accord with the law of mass action, this law broke down completely in the case of strong electrolytes, *i.e.* of all the common salts, as well as the stronger acids and bases. Many formulæ have been devised in the hope of discovering a law of dilution which should be applied to these perfectly normal, but obstinately intractable, electrolytes; but modern theory has turned back to an old expression of Kohlrausch, $\Lambda_c = \Lambda_\infty - a\sqrt{c}$, according to which the equivalent conductivity Λ_c , at concentration c , is less than that at concentration 0, by an amount $a\sqrt{c}$ which is proportional to the square root of the concentration. This law, which can be tested

by plotting Λ against \sqrt{c} , has been verified for a large number of salts both in aqueous and in non-aqueous solutions, and appears to have a wide range of validity; but the constancy of the index was challenged in a paper by Ferguson and Vogel, who assert that the index varies from 0.38 in barium bromide to 0.635 in lithium perchlorate, although the average for thirty-three salts is only just below 0.5. The theory of Debye and Hückel has the merit of deducing Kohlrausch's law from the fundamental laws of electrostatics, so that the index $\frac{1}{2}$ appears as an echo of the index -2 of Coulomb's law.

The theory of Debye and Hückel is based on the postulate that each negative ion in a solution is surrounded by a region containing an excess of positive ions, and conversely. Such a distribution is quite practicable, since it is realised in the lattice of the crystalline salts; thus, in the case of sodium chloride, the closest neighbours of a sodium ion are 6 chloride ions, followed by 12 sodium ions at a rather greater distance, and then by 8 more chloride ions at a slightly greater distance still. In electrolysis, this surrounding atmosphere of ions is drawn through the solution, and creates an increased frictional resistance by dragging the solvent with it, as in the phenomenon of electrophoresis. Moreover, since the atmosphere of oppositely charged ions lags behind the ion under consideration, as soon as it begins to move, a retarding electrostatic potential will be set up, the strength of which will depend on the rapidity with which the excess of oppositely charged ions is dissipated in the rear of the moving ion and collected in the new region into which it is advancing. The calculation of the magnitude of these effects presents a very difficult problem in statistical mechanics, but it can be shown in both cases that the resultant decrease of equivalent conductivity is proportional to the square root of the concentration. Kohlrausch's law can therefore be explained as due to variations of ionic mobility, resulting from the phenomenon of interionic attraction, without requiring any variation in the number of ions involved in carrying the current.

The formulæ of Debye and Hückel give results which are not yet in precise numerical agreement with experiment, although a closer agreement is obtained by making use of a modification due to Onsager, in which (by allowing for the Brownian movement of the ions) the numerical factor is reduced in the ratio 1:0.586. It is, however, a fact of fundamental importance that the theory of interionic attraction has at last provided a physical basis for Kohlrausch's law, since the earlier theory of electrolytic dissociation led to an entirely different, and incompatible, relationship between conductivity and concentration. On the other hand, it is a disappointment to find the old warning repeated, and in a still more emphatic form, that the formulæ now used are only valid in 'dilute solutions,' and that a close concordance between theory and experiment is not to be looked for in solutions of greater concentration

than N 100 or N , 1000, since it was at least reasonable to hope that the new theory of strong electrolytes would be applicable to strong solutions also.

An important question was raised at the discussion as to whether the theory of strong electrolytes requires that *all* the ions must be free, even in solutions of high concentration. The momentary existence of pairs of ions which have insufficient kinetic energy to separate from one another appears to present no difficulty, and may perhaps be covered by the existing equations. Numerical calculations suggest that the number of these neutral doublets is small; but as the new formulæ are only valid for solutions of extreme dilution, no experimental verification of these calculations is possible. On the other hand, Walden's observations of the small conductivity of salts such as $[\text{NEt}_4]^+\text{I}^-$, when dissolved in solvents of low dielectric capacity, indicate that the proportion of electrically neutral doublets may under some conditions be quite as high as that of the undissociated molecules of Arrhenius's theory. The same conclusion can be deduced in a still more emphatic form from the fact that potassium bromide behaves as an insulator when dissolved in liquid bromine, although phosphorus pentabromide acts as an electrolyte in this solvent.

During the discussion the position was generally adopted of classifying as 'weak electrolytes' all those compounds in which real molecules can be formed from the ions. This classification can scarcely be valid, since hydrochloric acid has all the properties of a 'strong electrolyte,' in spite of the fact that anhydrous hydrogen chloride has just as much claim as hydrogen cyanide to be regarded as a covalent compound. These neutral molecules are, however, so readily ionised by contact with water that it is only in concentrated solutions that they become sufficiently numerous to produce a marked vapour pressure. Since the theory of Debye and Hückel only applies to dilute solutions, it may be taken for granted that no difference would be detected by means of it between a strong electrolyte which is wholly ionised even in the solid state, and one in which the real molecules of the crystal are resolved almost completely into ions by the influence of an ionising solvent; in a hydrocarbon solvent, on the other hand, both types of solute would behave as weak electrolytes.

The problem of solvation was also discussed. Mr. R. H. Fowler expressed the view that, since water behaves as a dipole, it must be attracted towards the ions, and especially to those of small radius. A pressure gradient would thus be set up which would check the approach of all other ions, whether of similar or of opposite sign. The orientation of the water molecules would be reversed with the sign of the ions, as suggested by Ciamician in 1891, and formulæ expressing this view were included in a paper by Ulich.

The applicability of Stokes's law to ions was repeatedly challenged, as also was Walden's relation between mobility and viscosity; but it seems likely that these relations will continue to be

used in future arguments in reference to the mechanism of conductivity, if only as providing a standard from which deviations can be measured. On the other hand, it is equally clear that all such arguments will henceforth be dominated by the theory of interionic attraction, in one form or

another. The Faraday Society is therefore to be congratulated on having secured so lively a discussion of the subject. This discussion, with the twenty-seven papers circulated before the meeting, will provide the basis for a most valuable report.
T. M. L.

Obituary.

DR. ABRAHAM LEVIN.

THE tragic death of Dr. Abraham Levin on April 20, within a few minutes of leaving his laboratory at Plymouth, deprives physiology of a young and brilliant worker. A man of versatile talents, he showed from an early age a remarkable mechanical ingenuity and an extraordinary aptitude for engineering. This subject he studied in Rome, but long-continued ill-health, exaggerated in later years by privation during the Russian revolution, prevented him pursuing this study further. He therefore turned to other less exacting activities and studied music at Kieff with great success.

At the outbreak of War, Levin took up the study of medicine at the Crimean University at Simferopol, where he took his M.D. Prof. Gurvitch recognised his ability and made him his assistant. His mechanical bent resulted in the invention of a highly ingenious sphygmometer. Being able to come to England in 1924, his tireless mental energy found an ideal outlet in research with Prof. A. V. Hill at University College, London, and at the Marine Biological Laboratory, Plymouth. Levin's mechanical ability here stood him in the greatest service and enabled him to perform many beautiful experiments on the viscosity and elasticity of muscle and on the action current in nerves, as his published work shows.

Unfortunately, much of Levin's work is not yet finished; he died in the middle of a series of experiments on the action current in Crustacean nerve, which promised to yield results of the highest importance to the theory of nervous conduction and excitation. He was a man of the highest promise in his field of research, and his early death is a very great loss. C. F. A. P.

THE issue of the *Physikalische Zeitschrift* for Feb. 15 devotes twelve pages to the obituary address delivered in the hall of the Physikalisch-Technische Reichsanstalt at Charlottenburg on Dec. 18 by Dr. F. Henning, following on the death on Sept. 19 of his friend and colleague Dr. C. F. L. Holborn, head of the Heat Section of the Reichsanstalt. Dr. Holborn was born at Göttingen on Sept. 29, 1860, and after attending the local Realschule entered the University in 1879, and passed the government examination for teachers in 1884. He elected not to teach, but entered the Observatory as assistant to Schering in the terrestrial magnetism department, and in 1887 took his doctor's degree with a dissertation on the daily variation of the magnetic elements. In 1890 he joined the Reichsanstalt as assistant and rose gradually to be head of the Heat Section.

For a time in 1924 he acted as director of the establishment, and the date of his retirement from office was put three years later than the usual age of sixty-five years. His work on the temperature scale and on the thermal properties of gases has proved of great value for both science and industry.

WE regret to record the death of Sir Philip James Hamilton-Grierson, who died suddenly on Monday, April 25, at Kemnay, Aberdeenshire, at the age of sixty-six years. He was educated at Cheltenham College and Merton College, Oxford, taking his degree in 1876. A member of the Scottish Bar, he held a number of legal appointments in Scotland, was knighted in 1910 and received the honorary degree of LL.D. from the University of Edinburgh in 1920. In addition to editing a number of legal works, he was the author of several articles which appeared in Hastings' "Encyclopædia of Religion and Ethics," but his most important contribution to scientific literature was "The Silent Trade: A Contribution to the Early History of Human Intercourse," a valuable book in which he brought his legal training to bear upon the facts and underlying principles involved in primitive systems of economics and exchange.

WE regret to announce the following deaths:

Dr. A. W. Brightmore, engineering inspector at the Ministry of Health and formerly professor of structural engineering at the Royal Indian Engineering College, Cooper's Hill, on April 20, aged sixty-two years.

Dr. W. Collingridge, formerly Medical Officer to the Port of London and the City of London, on April 29, aged seventy-three years.

Prof. W. H. Dall, palæontologist of the U.S. Geological Survey since 1885 and honorary curator of the Division of Mollusks of the U.S. National Museum since 1869, on Mar. 27, aged eighty-one years.

Mr. E. T. Dumble, consulting geologist in Texas and formerly State geologist, who contributed notably to our knowledge of the economic geology of the Pacific slope, on Jan. 27, aged seventy-four years.

Dr. Charles E. Marshall, director of the graduate school and professor of microbiology at the Massachusetts Agricultural College, on Mar. 20, aged sixty years.

Prof. C. C. Nutting, professor of zoology in the State University of Iowa, and vice-president in 1902 of Section F of the American Association for the Advancement of Science, who was known for his work in marine systematic zoology, and particularly on the Coelenterata, on Jan. 23, aged sixty-eight years.

Prof. E. H. Starling, F.R.S., Foulerton research professor of the Royal Society and formerly Jodrell professor of physiology in the University of London, on May 2.

News and Views.

A STRONG commission, commencing under the chairmanship of the late Lord Milner, and comprising among others Sir Arthur Shipley, Sir Daniel Hall, Sir John Farmer, Dr. A. W. Hill, and Mr. F. B. Smith, has lately reported ("Agricultural Research and Administration in the Non-self-governing Dependencies." Report of Commission, Cmd. 2825, London, H.M.S.O., 1927. 2s.) on the question of the difficulty experienced in recruiting officers of satisfactory ability for research and administrative work in the non-self-governing colonies of the British Empire. The difficulty is largely put down to lack of general interest in the development of these colonies, though they form a sixth of the area of the Empire, and have 50 million inhabitants. An interim report has already been issued, upon which action has been taken by establishing a number of scholarships, similar to those provided by the Empire Cotton Growing Corporation, whose incumbents, after taking a degree similar to the Cambridge Science Tripos, Part II., shall spend one year in special training in Great Britain and one year in the Imperial College of Tropical Agriculture in Trinidad. In this way it is hoped to form a kind of reservoir from which the colonies may draw trained men, who will have had at any rate one year of tropical experience under proper guidance.

THE second part of the report before us deals with the collection and dissemination of information about the research and other work that is in progress in the different colonies, and it is recommended that a kind of central clearing-house, upon the lines of the Imperial Bureaux of Entomology and Mycology, be established in London for the purpose of collecting, abstracting, and compiling and issuing a periodical summary of information. The third part then goes on to deal with the organisation of research, and it is recommended by a majority of the Commission that a central advisory council be established in England, the chairman of which (a distinguished man of science) and secretariat shall be full-time officers, the former also travelling into the various colonies to see at first hand what is being done and to advise upon the spot. The duty of the council would be to collect information as to the work going on in every dependency, and to advise and criticise. The whole report is worth careful perusal.

DR. R. H. PICKARD has been appointed Director of the British Cotton Industry Research Association in succession to the late Dr. A. W. Crossley, who resigned the post shortly before his death on Mar. 5 last. During the past seven years Dr. Pickard has been Principal of Battersea Polytechnic, and to the responsible duties of this post he has added those of the directorship of the British Leather Manufacturers' Research Association. From 1899 until 1907, Dr. Pickard was head of the Chemistry Department of Blackburn Municipal Technical School, and afterwards principal of the same Institution until his appointment to Battersea. During this period Dr. Pickard,

in collaboration with his staff, published numerous papers in the *Journal of the Chemical Society*; for the most part these deal with the preparation of the isomeric borneols and menthols in a state of optical purity, and also with the synthesis and extended examination of a very large number of optically active organic compounds of simple chemical constitution. Considered as a whole, this work forms one of the most important and systematic attempts which have been made towards the solution of the complicated and difficult problem of the relationship between chemical constitution and optical activity. This record as a scientific investigator, combined with the experience gained during the tenure of administrative posts of considerable responsibility, affords ample assurance that the various activities of the British Cotton Industry Research Association will continue to be maintained at a high level in the hands of the new Director.

DR. E. V. APPLETON'S discourse delivered at the Royal Institution on Friday, April 29, was entitled "Wireless Transmission and the Upper Atmosphere." It is now becoming more and more evident, he said, that the atmosphere has a profound influence on the transmission of radio waves through it and thus on radio telegraphy generally. The earliest indication of atmospheric influence was Marconi's successful transmission across the Atlantic in December 1901. The distances previously accomplished by Marconi were so short as to be explicable on the simple hypothesis that the radio waves travelled in straight lines. But communication to America, as the late Lord Rayleigh was the first to realise, raised a new question. Could the waves bend round the protuberance of the earth, as sound waves bend round a corner? Lord Rayleigh and others investigated the problem mathematically, and their results showed that some influence other than ordinary diffractive bending was at work. We now know that this other influence is the so-called Heaviside layer of electricity in the upper atmosphere, which guides long radio waves round the earth's curvature. All recent work has tended to prove the Heaviside layer theory, and within the last two years it has been shown that the signal fading, with which many broadcast listeners are familiar, is also due to the action of this layer. This signal fading is most marked at a distance of 100 to 150 miles from the transmitting station and is due to the interfering action of the waves sent back to the ground by the Heaviside layer.

EXPERIMENTS made in conjunction with the B.B.C. engineers and the National Physical Laboratory show that the height of the Heaviside layer is about 70 km., rising to 120 km. during the night and falling to its lower value with the advent of sunrise. The layer is only found to reflect broadcast waves copiously at night, there being practically no reflection during the day-time, when the ground waves only are received. Experiments on the very short wave-lengths have shown that the ground waves die out very rapidly with increasing distance, so that reception at great

distance is accomplished only by means of waves deflected by the upper atmosphere. But with decreasing wave-length the amount of bending the atmosphere can accomplish becomes less and less, so that with very short waves a penetration of the Heaviside layer becomes feasible, especially at night when the amount of electricity in the upper atmosphere is least. Waves of the order of one metre in wave-length would penetrate it and thus be of no use for long-distance communication on the earth. A surprising result has recently been found in the effects of magnetic storms on radio transmission. Such storms interfere very seriously with long-distance short wave transmission, and yet with very long waves the signals are stronger than usual. It is possible to explain these results in terms of the Heaviside theory if we assume that a magnetic storm increases the electricity in the layer. In such a case the short waves which have to penetrate the layer to be bent gradually back to the ground are more strongly absorbed, because they are returned at lower levels where the friction experienced by the electricity is larger. On the other hand, the long waves are truly reflected by the layer at its surface, and an increase in the amount of electricity in the layer increases the amount of this reflection.

AN exhibition of modern British architecture was opened by Viscount Peel at the Royal Institute of British Architects' galleries on April 26. Organised by the Institute, this constitutes a new event to be repeated annually. It may be asked why, with the architectural room just opened at the Royal Academy, such a new departure is necessary. The explanation is twofold—the limited space at the Academy and the decision of the promoters of this new exhibition to admit photographs. Lord Peel in his speech referred to the Swedish and American exhibition of architecture previously held by the Royal Institute, and to the value of arousing the dormant artistic tastes possessed by a large section of the public by the display of good examples of current work; he also referred to the danger of producing rural slums by the indiscriminate erection of small houses without adequate artistic advice. The exhibits consist mainly of photographs, though there are a number of important buildings represented as perspectives in colour. Most of the works present domestic architecture, and it is noticeable that the grandiose buildings of the past have given way to smaller and simpler types of houses. Public buildings are also well represented, and there are examples of schools and other institutions; but visitors expecting to see interiors showing the application of the architect's work to the technical problems required to meet the needs of the man of science will be disappointed. Such a display is, however, apparently outside the scope of the exhibition. The galleries will remain open until June 3.

IN a lecture given under the auspices of the British West India Committee on April 28, Mr. Ormsby-Gore, Under-Secretary of State for the Colonies, described the work of the Empire Marketing Board.

Its tasks, he said, are to bring home to every section of the community the idea and the significance of the British Empire and its resources, and to mobilise the forces of research, both economic and scientific, to assist in the better production, distribution, storage, and marketing of Empire products. To ensure the greatest possible co-ordination of research work and to guard against unnecessary overlapping, a small Research Committee has been formed. Applications for grants for scientific research are either received through the appropriate Government department or referred by the Committee to the appropriate department for consideration and advice. Grants are in general limited to researches which are likely to be of importance to the Empire as a whole and not merely of local importance: for example, research in animal nutrition and in entomology. The latter field of research is of the utmost importance, as it is estimated that one-tenth of the world's crops are destroyed by insect pests yearly. The Board is sufficiently impressed with the results already achieved in connexion with the biological control of insect pests to make a grant of £15,000 a year for five years for the establishment and maintenance in England of a sort of 'parasite zoo,' where parasites destructive of insect pests can be bred and distributed wherever needed throughout the Empire. By such work as this it is hoped that the Board will earn the support of all political parties in Great Britain and also that of the various Governments of the Empire.

THE spring floods of the Mississippi have attained unusual proportion this year. They are due to the melting of snow in the northern part of the vast drainage area of the river in March, combined with the spring rains of April. A recent article in the *Times* points out how these floods periodically attain dangerous proportions, threatening all the lower flood plains and delta of the river, which are protected from normal inundation by levees or embankments, partly of natural growth and partly of artificial construction. The last severe floods on a large scale were in 1912, and some twenty-two years earlier the floods were so heavy that the levees protecting New Orleans were breached and parts of the city inundated. This year the floods of the two rivers Arkansas and Yazoo, dammed back by the main torrent of the Mississippi, have already flooded great areas. But the most serious danger lies in the rise of water in the delta where New Orleans lies, protected by levees, ten to fifteen feet below the normal river level. In order to drain away the waters before they inundate the city, a breach has been made in the levee at Poydras, fifteen miles below New Orleans. Many miles of swamp and copse, chiefly the resort of trappers, have thus been flooded, but this measure may save New Orleans.

SIR ROBERT HADFIELD has generously provided a sum of about £200 towards the expenses of a member of the Institution of Mining and Metallurgy who would be of special service at the forthcoming Empire Mining and Metallurgical Congress in Canada, but

would not be able to attend without financial assistance. A committee was appointed by the Council of the Institution to allocate the grant, and has recommended that it be offered to Assist.-Prof. Bernard W. Holman of the Mining Department of the Imperial College of Science and Technology, South Kensington. Prof. Holman had a distinguished career as a student at the Royal School of Mines, he has made noteworthy contributions to the publications of the Institution of Mining and Metallurgy, and he is a good speaker in discussions. He spent 1925-26 in South Africa, where he made a good impression in the mining fields, and it is thought that his presence at the Canadian meeting will be useful in discussing the proposed programme for the third congress, to be held in South Africa, apart altogether from his value in discussing the purely technical papers which will be read.

THE Easter Conference of the Society for Experimental Biology was held in Cambridge on April 19 and 20 in the Physiological and Zoological Laboratories, by kind invitation of Profs. J. Barcroft and J. Stanley Gardiner. A number of very interesting papers were read during the three sessions of the Society. Dr. E. Delf gave an account of her recent work, showing the beneficial effect of small doses of ultra-violet light on plants. Dr. A. S. Parkes discussed the relation of oestrin to corpus luteum. Dr. G. V. Anrep explained the present position of our knowledge of cortical activities as elucidated by the study of conditioned reflexes. Mr. J. T. Saunders showed a beautiful series of experiments illustrating chemotaxis in ciliata to *pH*. Dr. E. D. Adrian gave an account of his recent work on the nature of the nervous impulse in sensory nerves. Mr. J. Gray gave a critical account of the rôle of gravity in cell-division. Prof. J. S. Huxley described the induction of premature metamorphosis in *Echinus* larvæ following chemical inhibition of the larval tissues. An important feature of the conference was a symposium on the relation of evolution to heredity and environment, conducted by Mr. G. C. Robson, Mr. J. B. S. Haldane, Mr. C. E. Diver, and Dr. F. A. E. Crew. The complete adequacy of natural selection acting on Mendelian variation was pointed out, particularly in the case of small variations, and the importance of the environment both in originating mutation and in selecting the variants was demonstrated.

A JOINT meeting of the vice-presidents and members of the Councils of the Institution of Fuel Technology and the Institution of Fuel Economy Engineers was held under the chairmanship of Sir Alfred Mond on Friday, April 29. As president of both Institutions, in November last, Sir Alfred Mond, having found a general desire amongst those interested in problems of fuel economy that the two existing Institutions should be merged into one, suggested terms of fusion. Under the terms of fusion finally accepted, the name of the merged Institutions will be "The Institute of Fuel"; and the present honorary secretaries of the parent Institutions will be joint honorary secretaries of the new Institute. At the meeting the final steps

for the fusion of the existing Institutions and the inauguration of the Institute of Fuel were taken. Sir Alfred Mond expressed his great gratification that the fusion had been successfully accomplished. He said that the essential importance of the problems connected with fuel economy and fuel technology to the future of British industry is becoming increasingly recognised. The Government is vitally interested in the subject, and has appointed a National Fuel and Power Committee to investigate and consult upon the various problems in their many aspects. That Committee is progressing satisfactorily with its work, and it is of the utmost importance that there should be a unified Institution, important in numbers and personnel, to investigate, advise, and instruct the committee and the community on these highly technical matters. Mr. H. L. Pirie and Mr. Edgar C. Evans were afterwards appointed joint honorary secretaries of the Institute of Fuel.

THE first conversazione this year of the Royal Society will be held on Wednesday, May 11, at 8.30 P.M.

THE King has been pleased to nominate Dr. H. H. Dale, head of the Department of Biochemistry and Pharmacology, Medical Research Council, to be, for five years, a member of the General Council of Medical Education and Registration in the United Kingdom, in succession to Sir Nestor Tirard.

PROF. RICHARD WILLSTÄTTER will deliver the Faraday lecture of the Chemical Society on May 18, at 5.30 P.M., taking as his subject "Problems and Methods of Enzyme Research." The lecture will be delivered in the theatre of the Royal Institution, 21 Albemarle Street, London, W.1.

DR. R. J. TILLYARD, Chief of the Biological Department, Cawthron Institute, Nelson, New Zealand, has been elected an honorary member of the Entomological Society of Belgium. There are only six of these honorary members, and Prof. E. B. Poulton, Hope professor of zoology in the University of Oxford, is the only other British scientific worker among them.

At the annual meeting of the Members of the Royal Institution, held on May 2, the following officers for the ensuing year were elected: *President*: The Duke of Northumberland; *Treasurer*: Sir Arthur Keith; *Secretary*: Sir Robert Robertson.

A PUBLICATION grant of £2500 is receivable by the Royal Society from H.M. Government during the current year. The grant is available for assisting the publications of other scientific societies, as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grants will be adjudged by the Council of the Royal Society at its meeting early in July, but should be received before the council meeting of June 10. Applications from societies will be received by the secretaries of the Royal Society; those from individuals must be brought forward by members of Council.

THE Rockefeller Medical Fellowships for the academic year 1927-1928 will shortly be awarded

by the Medical Research Council, and applications should be lodged with the Council not later than June 1. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in Great Britain. A Fellowship will have the value of not less than £350 a year for a single Fellow, and travelling expenses and some other allowances will be made in addition. Full particulars can be obtained from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

THE Physiological Society was founded in 1876, and its fiftieth Anniversary was in 1926. Owing to certain difficulties the celebration of the jubilee was deferred until this year. On Friday, May 13, the Society is holding its jubilee dinner. This will be followed by an ordinary meeting at Cambridge on Saturday afternoon, and on Sunday, May 15, Prof. and Mrs. Barcroft are giving a garden party in the Fellows' Garden of King's College.

PHYSICS generally will benefit considerably under the will of the late Prof. A. W. Scott, Phillips professor of science at St. David's College, Lampeter, who died on Mar. 7 at the age of eighty-one years. The University of Cambridge is to receive £7000 and the Royal Society £1000, the income from which is to be applied for the promotion of the physical sciences, and the British Association, the Physical Society, and the Institute of Physics are to receive £250 each. The residue of the estate, after sundry bequests, is to be divided into three equal portions, two of which are to go to the Universities of Oxford

and Cambridge respectively, in each case "for the furtherance of physical science."

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in chemistry at the Cardiff Technical College—The Principal, Technical College, Cardiff (May 14). A resident director of the National Gallery of Ireland—The Registrar, National Gallery, Dublin (May 19). A senior lecturer in education in the University of Manchester—The Registrar, The University, Manchester (May 19). A lecturer on pharmacology and therapeutics at St. Bartholomew's Hospital Medical College—The Dean, St. Bartholomew's Medical College, St. Bartholomew's Hospital, E.C.1 (May 20). Two research workers at the Low Temperature Research Station, Cambridge, for researches into the principles of canning foods of animal and vegetable origin—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (May 21). A veterinary inspector under the Hertfordshire County Council and the Hereford City Council—The Clerk of the County Council, Shirehall, Hereford (May 21). A lecturer in chemistry in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (June 1). A lecturer in biology and botany at the Birmingham Central Technical College—The Principal, Central Technical College, Suffolk Street, Birmingham. An assistant bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum, and a laboratory assistant under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. A laboratory mechanic in the engineering laboratories of the Northampton Polytechnic Institute—The Principal, Northampton Polytechnic Institute, St. John Street, E.C.1. An analytical chemist—Crosse and Blackwell, Ltd., Soho Square, W.1.

Our Astronomical Column.

THE COMING SOLAR ECLIPSE.—It is evident that a keen and widespread interest prevails concerning this phenomenon, so rare in England. Many pamphlets on the subject are appearing. We have received one that is published by the Burnley Grammar School. Burnley lies within the totality zone but near its southern edge. The pamphlet was largely drawn up by members of the sixth form and gives in simple terms the conditions for eclipses in general and this one in particular. There is a warning that observers in Yorkshire should not select stations with high ground to the east of them, as morning mist is prevalent in such places. A large-scale map of the district (3 miles to 1 inch) includes Caton, Giggleswick, Settle, Stonyhurst, Colne; and shows the loci of different durations of totality, and of mid-eclipse at times 5 seconds apart.

Among the hints to photographers is the suggestion that attempts should be made to obtain colour photographs of the corona and prominences; this suggestion is also made by Mr. F. J. Hargreaves (*B.A.A. Journal* for March), who gives useful notes on the different screen plates and their ratios of exposure. Two small errata in the Burnley pamphlet may be noted: p. 13, for Sivar read Sivan; p. 15, the Norway eclipse was in 1851, not 1857.

Dr. Comrie has revised the eclipse calculations, using the latest available positions of the sun and moon. He finds that the track is likely to be 1 mile north of the Almanac position and the time 5 seconds later: the alteration is chiefly due to the deviation of the sun from Newcomb's Tables. With regard to some alarmist paragraphs on the subject in the daily press, it should be noted that uncertainties of similar amount are inseparable from all eclipse predictions, and that the only people appreciably affected are those very near the southern limit of totality, who should if possible move a little farther north.

The Astronomer Royal has announced that radio time signals will be sent out at 6^h, 6^h 15^m, and 6^h 30^m (summer time) on the eclipse morning. These will be the usual 6 dots, the last of which is the exact minute.

All observers can do useful work by noting the exact time of the beginning and end of totality, correcting their watches by the radio signals, and indicating their exact locality, which may be done on a tracing from the 1-inch Ordnance map (or a larger scale). Merely saying "in Settle" or "in Burnley" is not near enough for this purpose.

Research Items.

THE KHALLAM.—Miss Erna Gunther has made a careful study of the Khallam, embodying existing literature, which is not extensive, in addition to her own personal observations. This has now appeared as No. 5, vol. 6, of the *Publications in Anthropology of the University of Washington*. The information obtained in the field was mainly collected at Jamestown, Washington Harbour, and Esquimaux, but the Khallam formerly lived on the southern shore of the Strait of Juan de Fuca from the mouth of the Hoko River to Port Discovery Bay opposite Vancouver Island. They thus live in the region designated by Wissler as "the Salmon area," which extends along the Pacific Coast from Alaska to San Francisco bay. Their villages were for the most part on the coast, and their principal means of subsistence was sea food, especially salmon. Characteristically, agriculture was non-existent, vegetable food being obtained by gathering wild products—berries and roots. Each village, however, as a rule had one or two hunters, depending entirely on bow and arrow, who alone knew the mountainous country behind the shore. The villages consisted of a single row of rectangular houses with doors facing the water. The smaller houses were twenty feet by thirty feet; the potlatch house was fifty feet by two hundred feet. In camping, mats were carried to form temporary shelters. Their marriage regulations differed according to the social standing of the individual. People of high rank married outside the tribe; but such a marriage was only possible to families of considerable wealth; and although marriage with a relative was avoided, union with a cousin might be necessary in order not to mate with a person of lower rank. Poor people who could not marry outside the village or tribe because of the expense of the feasts involved made the best arrangements they could, avoiding parallel and cross-cousin marriages. Marriages with the northern tribes were the most desired. Most of the people are now Shakers, and it is difficult to obtain any complete account of the old religion, but, as in most of the American tribes, the secret society and the guardian spirit were prominent, while there was little idea of superior deities whom every one worshipped.

THE DISPOSAL OF THE DEAD AT WAKCHING, ASSAM.—Mr. J. H. Hutton has obtained details with photographs of a remarkable method of disposing of the dead at Wakching, a village of the Konyak tribe in the Naga Hills, which are published in *Man* for April. After death, the body is wrapped in leaves of the thatching palm and placed in one of a number of trees, usually six, associated with and usually near the *morungs* of the clan using them. Outside the village a rail is put up, with a screen, in front of which is a wooden figure of a man serving as the temporary habitation of the soul. This figure, which ends just below the waist, can be and is used for other dead afterwards. After nine days the head is detached from the body and cleaned by the children or relatives and placed in the village cemetery in a special stone receptacle. This is a solid conical sandstone block from two to three feet in height, with an arched recess to take the skull. The recess is closed with a flat stone and the whole covered with a conical sheath of thatching palm leaf. The skulls of males and females are treated in the same way, but the receptacle for females differs in shape. The fact that persons desirous of having children perform ceremonies over the stones confirms the view that they have a phallic significance. Many of the stones are ornamented with various carved patterns. Persons who die a violent death, or from

an epidemic, and children, are not treated in this way. The custom of disposing of the skulls of the dead in phall of carved stone is apparently limited to Wakching and the neighbouring hostile village of Wanching. It forms a definite link between the menhir and the carved wooden soul figure and with related customs, another link between Assam and the Pacific.

HYBRID VIGOUR IN GRASS.—The results of cross- and self-fertilisation in the grass *Lolium perenne* are reported in a paper by Mr. T. J. Jenkin (*Jour. of Genetics*, vol. 17, No. 1) from the Welsh Plant Breeding Station at Aberystwyth, where much work with grasses for pasturage is being done. Some plants were found to be highly self-sterile, and cross-pollination resulted in some cases in an increase in productivity of more than 200 per cent. It appears, therefore, that seed should be used from crosses which give the greatest F_1 hybrid vigour. Two methods of cutting were also compared, in one of which the early cuttings were omitted. The latter method gave higher yields in every case, but in some F_1 families the difference was much greater than in others. Hence it would probably be possible to select certain plants which are more suitable for grazing purposes and others which are better for hay production.

INHERITANCE OF RUBBER YIELD.—The relationship of latex yield to various other features of the rubber tree, *Hevea brasiliensis*, has been studied statistically by Mr. R. A. Taylor (Bull. No. 77, Dept. of Agriculture, Ceylon). A plot of 161 trees was studied, all the trees being the progeny of a single tree at Peradeniya which is believed to be one of those sent out as a seedling from Kew in 1876. This tree had a very heavy yield, producing nearly 400 lb. of dry rubber in four years nine months. The pollen parent of these 161 trees was not controlled, but the coefficient of variation in their yield is much lower than in trees of mixed parentage. Correlation tables show a high correlation between yield in successive years. Frequency polygons show that a large number of the trees yield the mean amount or a little less, while very few show the high yields. The yield does not depend entirely on the number of rows of latex vessels. The number of rows in the cortex is characteristic of each tree, but some trees with a relatively low number have higher yielding power than other trees with nearly twice as many cortical latex vessels. In cortex renewed after tapping, the number of vessels remains about the same. A count of the vessels gives a better measure of the yield in older trees than in very young ones.

LIME ON THE FARM.—The Ministry of Agriculture has issued a revised edition of Leaflet No. 170, on the use of lime in agriculture. The practice of liming or chalking, though one of the oldest in British agriculture, has tended to be neglected during the last half-century, and the farms of to-day are suffering in consequence. The functions of lime are so numerous that it can be regarded as an all-round soil improver. Besides being an essential plant food, its presence is necessary to render artificial manures effective, and further, it acts as a corrective for soil sourness or acidity and greatly improves the working properties of heavy soil. Regular applications of lime are recommended, as a number of factors cause its depletion in the soil, and although crops vary as to their dependence on the lime supply, a well-limed soil yields more trust-

worthy results during critical periods of the season's growth. A need for lime may be indicated by the prevalence of certain weeds, e.g. spurrey, or plant diseases, e.g. finger-and-toe. A large number of the different forms of lime available are given, and their comparative values indicated, together with information as to the special points to be observed in the use of each form, and caution is advised as to the application of some waste lime products or lime rich in magnesia. The most suitable material to supply depends largely on the cost, but carbonate of lime can give as good results as burnt lime provided it is sufficiently fine and well distributed in equivalent quantity. Further, ground limestone and chalk have the additional advantage over lime in not deteriorating on storage, and in their harmlessness if applied to a growing crop. The time and method of application should be chosen with the view of ensuring the most perfect distribution. The quantity necessary to apply varies widely with the form of lime applied, but an average dressing of 10 cwt. to 1 ton per acre of ground lime, or 1 to 2 tons per acre of carbonate of lime once in four or five years is suggested.

THE GENUS CLEMENTIA IN AMERICAN TERTIARIES.—Apart from its value as a zone fossil in American Tertiary deposits, the chief interest of the genus *Clementia* (fam. Veneridæ) lies in the anomalous features of its present and former distribution. Mr. W. P. Woodring now seeks to trace its geological history, its palæobiological significance, and to describe all the known American species (U.S. Geol. Survey, Professional Paper 147—C). Eight forms, species and subspecies, with two doubtful species, are described and figured on four excellent plates. There is also a text map of the world marked to show the present range and past distribution of the genus.

THE MOLLUSCAN GENUS GISORTIA.—When last year (*NATURE*, vol. 117, p. 246) we recorded a posthumous paper by the late Dr. Vredenburg (died 1923) on the post-Eocene Mollusca of the Tertiary formations of north-west India, no further contribution from his able pen was anticipated. Now, however, a belated monograph by him on the cowry-like genus *Gisortia* has been published (*Mem. Geol. Surv. India: Palæont. Indica*, New Series, vol. 7, mem. 3). The generic name dates only from 1884, but so far back as 1825 one fossil and one recent representative were described. The latter, the Australian *Cypræa umbilicata* of Sowerby, remains the unique living example; but Dr. Vredenburg has described thirty-six species in all, going back in time to the Cretaceous period, many only known in the condition of internal casts. All are figured of the natural size on thirty-one photo-plates, and tables given of their stratigraphical distribution and probable zoological affinities. Judging from internal evidence, this monograph would appear to have been completed about 1917.

EARTHQUAKE PREDICTION IN CALIFORNIA.—The question of earthquake prediction is receiving renewed attention in the United States. After the San Francisco earthquake of 1906, two rows of four pillars each were erected across the San Andreas rift, along which the great movement occurred. Dr. J. P. Buwalda now proposes to extend the series so as to cover southern California, and the work is to be carried out under his guidance by the California Institute of Technology, in co-operation with the Carnegie Institution of Washington (*Daily Science News Bulletin*, Washington, No. 313 B). The monuments will be erected in straight lines across suspected earthquake-faults. If, after five or ten years, the lines remain straight, it will be

concluded that no great earthquake is in prospect there; but if the line should be distorted into the S-form, the situation will then be regarded as dangerous.

TIDES AND CURRENTS IN ALASKA.—The United States Coast and Geodetic Survey has issued the fourth volume in a series of publications on tidal and current observations made in the more important waterways in United States territory. Special publication No. 127 deals with south-east Alaska and is the work of Lieut. R. W. Woodworth and F. J. Haight. Tidal stations of some standing are now sufficiently numerous on this coast to permit of the discussion of tides for the main ship channels and principal parts. Unfortunately, there are as yet no stations in Glacier Bay, to the east of Lynn Channel, where the Alaskan glaciers that reach the sea must have a disturbing effect on the tides. Current observations, though of comparatively short duration, show a general north-westerly set in the waterways of south-eastern Alaska. The authors attribute this inshore current to a back eddy of the westerly drift across the north Pacific. The larger part turns south-east along the coast of North America, but a smaller part turns north and is driven into the inland passages by the prevailing westerly winds. The volume contains a useful appendix, reprinted from an earlier publication, on the general characteristics of tides and currents.

PEDESTAL ROCKS FORMED BY EROSION.—An interesting contribution to physical geology is made by Kirk Bryan in Bull. 790 A of the U.S. Geological Survey, where he deals with pedestal rocks formed in arid climates by differential weathering. It is shown that many other processes are operative besides wind abrasion, and examples attributed to chemical weathering, temperature changes, differential rainwash and sapping are described. Such processes are also operative in humid regions, but the life of the pedestals there developed is relatively short because of the rapidity of rock decay, and in the colder regions also because of the increased effectiveness of frost action. Moreover, in humid regions the formation of soil and the prevalence of vegetation inhibits the growth of pedestals except when the conditions are especially favourable, as for example when glacial erratics of insoluble rocks rest on a limestone platform.

TWO SHALLOW OILFIELDS IN TEXAS.—On Mar. 8 Dr. Arthur Wade read a paper before the Institution of Petroleum Technologists on the Sipe Springs and Deep Creek oilfields of Texas, both developed in what is technically known as the South Mid-Continent region. In the case of Sipe Springs the area is essentially an inlier of Pennsylvanian (Canyon member) rocks surrounded by Cretaceous deposits, the relationship between the two formations being that of unconformability and overlap. The structure of the field is simple, the beds dipping west at an almost imperceptible angle, with indication of a terrace running from north to south; in this the field resembles many other South Mid-Continent oilfield structures, where often the appreciation of dip is only obtainable by levelling over a wide area. Oil is produced at Sipe Springs from two sands, one at 180 ft. to 200 ft. below the surface, the other 260 ft. to 300 ft.; the former sand is lenticular and production from it is erratic; the latter is a more persistent horizon and is productive throughout the field. In common with other fields in this region, the origin of the oil is doubtful: it may either be indigenous to one of the members of the Pennsylvanian, or it may have originated in the underlying Bend group (Mississippian) from which extensive migration is known to have

occurred. In the Deep Creek field the critical formation is that of the Putnam group, mainly clays with lenticular sandstones, shale, and limestone of rather uncertain age, lying between the Cisco member of the Pennsylvanian and deposits known to be of Permian age. The sandstones contain oil and gas, also salt water. The structure is not unlike that of Sipe Springs, but the westerly dip is slightly steeper. The Sipe Springs oil is of good quality with an average gravity of 0.83; that of the Deep Creek field is similar; in fact, considering that the oil of these fields is derived from distinctly different formations, the similarity of physical and chemical properties in both cases is remarkable.

LARGE VACUUM TUBE.—What is stated to be the world's largest vacuum tube, constructed by the General Electric Co. of America, has now been in use in a radio station for several weeks. It is seven and a half feet high and weighs 100 lb. It is rated at 100 kilowatts, and is kept cool by a copper jacket through which water is kept circulating. It takes the place of eight 20-kilowatt tubes, which were formerly used. Hitherto 50 kilowatts has been the maximum power given to the antenna of a 'super-power' radio station. A battery of the new tubes will permit experiments with 500 kilowatts in the antenna. This is one thousand times the power used by a typical broadcasting station three or four years ago. Two ounces of tungsten are used in the filament, which is as thick as the lead in a lead pencil, and is eight feet long.

DENSITY OF THE PHOTOGRAPHIC IMAGE.—In two papers in the *Proceedings of the Royal Society of Edinburgh* (vol. 45, pt. 2, p. 166; 47, pt. 1, p. 34) Dr. E. A. Baker describes in detail the large amount of experimental work carried out by him in connexion with Prof. Sampson's investigations on the temperature of a great number of stars by determining photographically the distribution of energy in their spectra. Dr. Baker's work consists essentially in a rigid calibration of the particular types of photographic plates used by Prof. Sampson, so that the true interpretation in terms of intensity can be given to the densities obtained on the plates when the time of exposure, the conditions of development, and wave-length of the light are varied. The author starts with a perfectly general expression connecting the intensity with the variable factors density, exposure time, and wave-length, and finds it convenient to consider two characteristics of the plates, which he calls p and q , and to determine how they are affected by variation in these factors. p is the so-called Schwarzschild constant and q is analogous to γ , the slope of the characteristic curve, and at higher density values is equal to p/γ . Amongst other interesting results it is found that for a constant blackening and constant exposure time, the variation of p with wave-length is very small, a result which is to be expected if p depends on the value of the effective intensity (i.e. the energy absorbed by the plate per second) and if equal effective intensities of different wave-lengths produce densities of the same order. The larger part of the second paper is devoted to a new theory of the relation between the number of grains of silver halide affected, the intensity of the incident light, and the duration of the exposure (see also NATURE, Sept. 11, 1926, p. 374). Without entering here into the details of the theory the conclusion is, to quote Prof. Sampson, "that the initial stages of the photographic action, including the deviations from the reciprocity law, are calculable and well represented by assuming that the developable product is formed in two stages, each stage requiring one quantum, and that the product of the first

stage returns in the absence of further stimulus to its original sensitive state, according to the law governing the progress of a mono-molecular change." The idea involves, apparently, two distinct kinds of absorbers of energy in the silver halide grains, one for each stage.

CALCIUM IN ALUMINIUM CONTAINING SILICON.—Mr. J. D. Grogan read a paper at the recent spring meeting of the Institution of Metals on "The Influence of Calcium on Aluminium containing Silicon." The addition of calcium to aluminium results in the formation of a compound, CaAl_2 , which is very slightly soluble in solid aluminium. By the addition of silicon to this alloy, the compound CaSi_2 is formed, which is practically insoluble in the solid state at all temperatures. Neither compound appears appreciably to improve the mechanical properties of aluminium, or to impart age-hardening properties. The addition of suitable quantities of calcium to aluminium containing silicon improves the electrical conductivity by removing silicon from solid solution. As the effect of CaAl_2 on the conductivity of aluminium is relatively small, the effect of a slight excess of calcium is not harmful.

MOLYBDENUM IN NICKEL-CHROME STEELS.—Report No. 67 from the Research Department, Woolwich, on "The Influence of Molybdenum on Medium Carbon Steels containing Nickel and Chromium," shows that the addition of molybdenum to nickel-chrome steels raises the AcI point but lowers ArI. In many cases the Ar point is depressed to 470°C .—Ar"—unless the rate of cooling is very slow. Molybdenum has a more powerful effect than nickel or chromium in reducing the liability to imperfect hardening when the rate of cooling is slow, and reduces the softening on tempering. About 0.5 per cent. of molybdenum is sufficient to bring about most of the possible improvement in these steels. The 'mass-effect' is reduced by the presence of the third alloying element, when the mechanical results show great uniformity even in the biggest forgings. Tests can be repeated with great regularity, indicating that the steels are unaffected by slight departures from standard conditions of treatment. The elastic properties, ductility, and impact value are all improved by the addition of molybdenum, which has the further great advantage that it has a pronounced effect in considerably reducing, or completely eliminating, the susceptibility of the steel to 'temper-brittleness.' Nickel-chrome-molybdenum steels provide the best all-round combination of properties, though nickel-molybdenum and chrome-molybdenum steels approach them nearly. When treated so as to give a tensile strength of 50 tons-60 tons per sq. in., the best composition from these three types of steel—in each case with a carbon content of 0.3 per cent.—are as follows: Nickel-chrome-molybdenum: Nickel 2.6 per cent., chromium 0.6-1.1 per cent., molybdenum 0.6-0.4 per cent.; steels in this range of composition all gave very similar properties when tempered to the same hardness, the higher chromium content being an advantage when a tensile strength of 60 tons per sq. in. or more is required. Chromium-molybdenum: Chromium 1.0-1.5 per cent., molybdenum 1.0-0.5 per cent.; slightly inferior in general properties but gives higher notched-bar impact figures. Nickel-molybdenum: Nickel 2.7-4.0 per cent., molybdenum 0.6-0.4 per cent.; rather better in yield ratio than the nickel-chrome-molybdenum steel but inferior in impact value; when the nickel exceeds 3 per cent., as is necessary to obtain a tensile strength of 60 tons per sq. in., these steels show distinctly lower impact values and also become difficult to machine.

The Embrittlement of Boiler Plates.

THAT boiler plates may become brittle in the course of time and in certain circumstances is now a well-established fact. All the conditions, however, which govern the phenomenon are by no means completely known, and the problem raises points both of great practical and of scientific importance. A paper entitled "The Cause and Prevention of Embrittlement of Boiler Plates," by S. W. Parr and F. G. Straub, Bulletin No. 155 of the University of Illinois Engineering Experiment Station, which deals with the subject at some length, is therefore of considerable interest.

It is first shown that of the recorded examples of brittle boiler plates in America, there are certain areas where the trouble is more evident than in others. This at once suggests that the water is the cause of the failures, and this is strengthened by the fact that in these localities the waters used are characterised by an almost complete absence of sodium sulphate and by the presence of free sodium bicarbonate. It is to the latter salt that the authors attribute the primary responsibility for the embrittlement. The type of boiler used is not believed to have any influence, since failure due to brittleness has occurred in a considerable number of different makes and designs, both fire- and water-tube. Further, the writers reach the very interesting conclusion that the steel from which the plates are made has *per se* no effect either. Their reasons for coming to this conclusion are as follows: Six different types of steel which had become brittle in actual boiler service were examined. The carbon content ranged from 0.14 to 0.26 per cent., the manganese from 0.26 to 0.54, the phosphorus was consistently low, and the sulphur varied from 0.018 to 0.046 per cent. Micrographic examination also indicated that good steel was just as liable to fail as low-grade, dirty material. In the experimental work described, steels were investigated in which the range of composition was:

Carbon	. . .	0.023-0.30	per cent.
Manganese	. . .	0.017-0.45	" "
Sulphur	. . .	0.007-0.027	" "
Phosphorus	. . .	0.003-0.012	" "

Apart from the question of the yield point, variation of the composition of the steel within this range had very little, if any, effect on the rate of embrittlement.

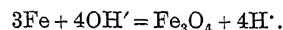
The experimental work on short-time, accelerated tests confirmed what had been previously believed, namely, that stress and the nature of the solution each played essential parts in causing brittleness. So far as the former factor is concerned, it is shown that this must exceed the yield point of the steel before failure commences. There are also indications that, provided this stress intensity is attained, the actual value of the stress is not of prime importance. As, therefore, the yield point of the material is raised, so will also be the stress to which the steel may be subjected in service without failure due to brittleness ensuing. Thus 3.5 per cent. nickel steel showed in the tests no abnormality other than the increased stress required to induce embrittlement. A steel severely cold-worked previous to test also appeared to require a rather higher stress to initiate the trouble than the same steel in the annealed condition. In connexion with the latter factor the temperature used in the annealing of the steels had very little effect. A fact recorded which is, however, somewhat difficult to reconcile with the foregoing is that with high sulphur and phosphorus contents the steel is more liable to become brittle; for example, a decided increase in

the rate of embrittlement is recorded for a material with 0.215 per cent. of sulphur and 0.126 per cent. of phosphorus compared with normal steel. The explanation offered for this effect of these elements is not convincing.

The examination of the surface of embrittled plates shows no corrosion, but there is, as in all cases, a layer of magnetic oxide of iron. So long as this is compact and complete, further attack on the metal is inhibited, but if for any reason the coating is broken, the unprotected metal surface is then again laid open to chemical attack from the solution. The importance of the yield-point stress is thus apparent. Under this stress there will be sufficient plastic deformation of the metal to fracture the oxide film and the attack will recommence.

So far, then, as the prevention of this embrittlement is concerned, one of the methods by which this could be done would be by cutting down the actual stress to a value below the yield point. This the authors regard, however, as being impractical. The failure is associated with the seams where the different plates are riveted together, the cracks produced running in general from one rivet hole to another and not extending into the body of the plates beyond the lap of the seam. Now, both in the operation of riveting and under the conditions of service, greatly concentrated, localised stresses must occur in such positions, and stresses exist there considerably exceeding the yield point even when the steel plate as a whole is far below its yield stress.

It follows, therefore, that the only effective protection will come from the consideration of the water used. As has already been mentioned, the characteristics of those natural waters which in the United States have led to this type of failure are the presence of sodium bicarbonate and a low concentration of the sulphate. In time, then, a caustic condition will be set up in the boiler with the sodium hydroxide in excess of sodium sulphate, and it is to this caustic soda directly that the embrittlement is ascribed. The reaction assumed to be responsible is represented by the equation



The hydrogen then passes into solid solution in the steel and leads to brittleness. This attack is shown to be a surface phenomenon by measurement of the e.m.f. of the original and brittle steel against caustic soda solutions and by the grinding off of the affected surface, when the e.m.f. value becomes again that of the untreated steel. In accelerated tests it was shown that a concentration of 350 gm. of caustic soda per litre is required to initiate the failure. This value, it is supposed, may in time be reached between the plates where they overlap, but it is also realised that such figures from accelerated tests need not necessarily apply to conditions in service, and that under prolonged application of stress even lower concentrations may be equally important.

Passing on to consider the treatments of the water which are possible and would lead to inhibition, the authors' view is that neutralising the alkalinity of the water with sulphuric acid could not be carried sufficiently far without endangering the boiler. It was found, however, that increasing the concentration of sodium sulphate or carbonate in relation to that of the hydroxide retarded and eventually prevented the attack. This effect has been studied for several years on an actual boiler, in which the feed-water was maintained with a ratio of sulphate to carbonate of 2 by neutralising about 70 per cent. of the alkalinity

with sulphuric acid. After ten years of operation the boiler is in perfect condition, whereas a similar plant using, apart from the water treatment, identical conditions, was condemned after nine years.

It is clear, however, that the treatment must be done under expert supervision. The same applies equally to the addition of aluminium or magnesium sulphate. This treatment is very effective when used in connexion with settling tanks and filters which remove the possibility of scale-forming ingredients entering the boiler, but if used in excess, the salts are distinctly harmful and the quantities added need careful control. Undecomposed sodium carbonate

acts as an inhibitant, and cases are on record where the sulphate-carbonate ratio of the water was exceedingly low without any indications of brittleness due to high sodium carbonate content. It is, however, well to regard the carbonate as the potential source of the hydroxide. The authors finally consider that the best ratio to adopt as standard in water treatment for boilers is that of the combined sodium sulphate and carbonate to the hydroxide. Although they are not yet prepared to suggest hard and fast figures, they believe that when this ratio exceeds 2, it is sufficient to stop the embrittlement.

F. C. T.

Whales and Dolphins.¹

THE scientific heads of the British Museum for many years (just as Dr. R. Knox, Prof. Goodsir, and Principal Sir William Turner did in the northern capital) have devoted much attention to the cetaceans, as seen in Dr. Gray's Catalogue, Sir R. Owen's *Kogia*, and the important publications of Sir William Flower—to whom the public owe the interesting Whale Gallery at the Natural History Museum, South Kensington, with drawings from life by his daughter. It was, however, reserved to the director who has just retired, Sir Sidney Harmer, to systematise the means for obtaining information of all the species—of this most intelligent and interesting as well as much persecuted group—caught or stranded on British shores. In the publication before us he has further added to the indebtedness of the public and men of science by summarising the results of his labours, which, by aid of the officials of the Board of Trade and others, have largely extended our information.

In few groups are there more striking examples of maternal solicitude than in the Right whale, or more conspicuous social instincts than in the Pilot whale. Such is proved by the cruel methods of the old whalers in harpooning the helpless young in order to secure the anxious mother, whilst in the latter group a single example will suffice—thus when more than two hundred were embayed with their leader, an old male, in Scalloway harbour (a kind of pocket with a narrow entrance), the leader dashed through both the inner and the outer cordons of boats and reached the open sea, but when he found he was alone he turned shorewards, again rushed past both lines of boats, and was killed in the midst of his followers in Scalloway harbour, where to this day their skulls make suitable wedges to support the boats.

The first part of Sir Sidney's memoir gives practical information as to measurements of specimens, the different kinds of Cetacea and their sex-characters, illustrated by excellent figures. A brief account of toothed and whalebone whales follows. As an appendix to the list of porpoises, the fact is recorded that in summer in Shetland no less than 100 to 150 may occasionally be seen disporting themselves close inshore in Bressay Sound—probably attracted by a shoal of fishes. The female porpoise gives birth to her young often in June, and she may be watched swimming in circles close inshore with it, or resting on her side with a flipper in the air as it suckles. To Sir Sidney's remarks on the various forms it may be added that some of the larger dolphins occasionally 'breach' like the Humpback whale from the side of a huge wave, again noisily striking the water. The Killer, besides occurring on the east coast, may often

be seen in the Sound of Raasay, not far from Portree in Skye, the long dorsal fin projecting above water, steadily propelled as if from a powerful screw.

The author makes important remarks on Cuvier's whale, formerly thought to be rare, especially in connexion with the prenarial basin of the male, about which he hazards the reasonable view that it "is occupied by derivatives of the two narial passages, perhaps diverticula which lie in the basin and are separated ventrally by the reduced prenarial part of the mesorostral." He also discusses skin-markings of whales, with remarks on age and disease, and the sizes of the newly born—quoting from Mr. R. C. Haldane's paper of 1905 (*Ann. Scottish Nat. Hist.*, No. 54) the fact that the young Finner when born is about 20 feet long, and that "sucking calves of 40 feet have been seen."

Tables follow with the Cetacea stranded in 1925 and 1926—27 in the former and 47 in the latter year. In his brief remarks on some of these the author observes that a white-sided dolphin caught in the beginning of August in the Loch of Stenness (near Stromness) at a time when Salps in large numbers pass from the Atlantic to the North Sea may have been attracted by them. Unfortunately, the contents of the stomach were not reported. This view would interest some in connexion with the Fishery Board for Scotland, who took the view that the hordes of Salps ousted the herrings from their usual haunts, the fact being that herrings and other fishes (if not whales) have, like birds and many invertebrates, a relish for Salps or part of them.

Under the tenth head a summary of the characters of the British toothed and whalebone whales, and a key for determining species, are given—a useful guide for all who come in contact with them, especially in such cases as True's Beaked whale, which has only occurred twice on the coasts of Britain.

Appended to the report are seven very useful quarto maps of the British Isles, the first indicating the stations where all the Cetacea during 1925 and 1926 were obtained, the field being generally dotted—with perhaps a denser grouping in the north. The second map is devoted to the common Dolphin, with maximum stations for 1913–1926 to the south and west, the latter areas also being in the ascendant for the Bottle-nosed and the White-beaked Dolphins. The other maps for the Killer, Hyperoodon, Cuvier's, Sowerby's, and True's Beaked whales, as well as the whalebone and spermaceti whales, are equally instructive for the period.

In dealing with the scientific names of the various species, the author throughout has unfortunately refrained from adding the name of the authority for each, probably to avoid complication.

The publication of this report will do much to facilitate the recognition of cetaceans by the public as well as to afford useful information to men of

¹ Report on Cetacea stranded on the British Coasts from 1913 to 1926. (No. 10.) By Sir Sidney F. Harmer. Pp. 91+7 maps. (London: British Museum (Natural History), 1927.) 7s. 6d.

science, and Sir Sidney Harmer is to be congratulated on his statistical and other labours, and the completion of so important a summary. It is to be hoped that his methods will be continued by the Museum on similar lines in future. Both in this respect and in his influence and exertions in connexion with the arrangements for the expedition in the *Discovery* and *William Scoresby* to the Falkland Islands in search of further knowledge of the life-history of the cetaceans, science and the public are deeply indebted to him.

W. C. M.

University and Educational Intelligence.

ABERYSTWYTH.—Prof. H. Stuart-Jones, Camden professor of ancient history in the University of Oxford, has been appointed Principal of the University College of Wales.

LONDON.—Three public lectures on "Some Surgical Problems" will be given at the Middlesex Hospital Medical School at 5 o'clock, on May 16, 17, and 18, by Prof. J. Fraser. A course of four public lectures on "Inflammation and Infection" will be given at Guy's Hospital Medical School at 5.30, on May 20, 27, and 31, and June 3, by Prof. E. H. Kettle. No tickets will be required.

MANCHESTER.—Applications are invited from persons born in or inhabitants of the County of Lancaster, preferably the County Borough of Rochdale, for the Sir Clement Roysds memorial scholarship in chemistry in the University of Manchester, the value of which is £300. The applications should be sent by, at latest, June 1 to the Registrar.

OXFORD.—A public lecture will be given by the Right Hon. Sir John Simon, M.P., on Saturday, May 7, at 12 noon, on "The Labrador Boundary."

The Romanes Lecture for 1927 will be delivered by Sir Frederic George Kenyon, Director and Principal Librarian of the British Museum, at the Sheldonian Theatre on Friday, June 17, at 5 p.m., on the subject of "Museums and National Life."

ST. ANDREWS.—The Senatus Academicus has resolved to confer the honorary degree of LL.D. upon Sir Richard Gregory and upon the Right Hon. Sir Alfred Mond, P.C., M.P., at the graduation ceremonial to be held on June 28.

Mr. G. J. Robertson has been appointed to the senior lectureship in the Chemistry Department of the United College of St. Salvador and St. Leonard, in succession to Dr. G. McOwan.

THE Salters' Institute of Industrial Chemistry is inviting applications, until June 1, for a limited number of fellowships, each of the normal value of from £250 to £300, from chemists of post-graduate standing who are desirous of adopting a career in industrial chemistry; also, until June 10, for a limited number of grants-in-aid to young men and women employed in chemical works in or near London who desire to extend their education for a career in chemical industry. The applications should be sent to the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4.

THE London School of Economics is making arrangements for a series of lectures and discussion classes on the ethnography of Africa. During the summer term Prof. C. G. Seligman will give a course

of lectures on "The Nile Valley and its Peoples." In the Michaelmas term of the session 1927-28, Mr. J. H. Driberg will give a course on "The Ethnography of East-Central Africa," and will deal with the ethnography of West Africa and also with the reactions of primitive African cultures to economic development in the following lent and summer terms, whilst arrangements will also be made for Mr. I. Schapera to give a course on the ethnography of South Africa. Further details of this and other lectures on ethnology can be obtained on application to the Secretary of the School.

UNIVERSITY COLLEGE, London, celebrates this year the hundredth anniversary of its foundation. On April 30, 1827, the Duke of Sussex laid the foundation-stone of what was in the first instance styled the University of London but was incorporated by Royal Charter in 1836 under the name of University College, London. Another separate body was chartered on the same day as the University of London, with power to grant degrees in arts, laws, and medicine, after examination, to candidates who should present certificates of having completed the requisite courses at University College and such other institutions as might be approved for the purpose. To-day, with more than three thousand students, including five hundred post-graduate and research students, and its graduation list of nearly three hundred, it has an importance not less than that of many full-fledged universities. Attracting students from many countries both within and outside the British Empire, it has a cosmopolitan character and makes its influence felt throughout the world. It is marking the completion of its first hundred years by a campaign for raising half a million sterling towards building and equipment and better endowment.

IN the Report of the Imperial College of Tropical Agriculture, Trinidad, 1925-26, the Principal, Dr. H. Martin Leake, gives an account of the lines upon which the College is developing. The completion and occupation of the new buildings is an outstanding feature of the past year; but owing to the increasing number of students, further accommodation is already required. A residential hostel is in course of construction but is not yet completed. The field from which students are drawn is widening; in the past year four came from the Union of South Africa and one each from Brazil, Egypt, and Ecuador respectively, in addition to those from the West Indies and Britain. At the same time students who have passed through the College are becoming widely distributed throughout the British Empire. The shortage of staff has again seriously restricted the output of research work, but the issue of the Fruit Report drawn up by the Imperial Economic Committee is an important feature. A large section of the work has been devoted to the subject of bananas, the question of greatest importance being to secure a variety immune from Panama disease and also of satisfactory carrying capacity. The Giant Fig fulfils the first of these requirements, but much further work is necessary before the optimum conditions for shipment can be determined. The serious problem of the froghopper pest of sugar-cane has also been actively investigated. The degree of attack is to a great extent dependent on the physiological condition of the plant, so that much fundamental work has to be done before the intimate relation between host and parasite can be elucidated. Such studies, however, will probably have an important influence on allied problems. Tobacco investigations have been extended, but the inadequacy of curing facilities has proved a hindrance.

Calendar of Discovery and Invention.

May 8, 1654.—One of the most striking demonstrations in physical science made during the seventeenth century was that of Otto von Guericke, who on May 8, 1654, before the assembled princes at Ratisbon, showed his great experiment with the big Magdeburg hemispheres which, when exhausted of air, could not be pulled asunder by sixteen horses.

May 8, 1795.—Though the planet Neptune was not discovered until 1846, yet it was shown as a star in Harding's Atlas of 1822, and on May 8 and 10, 1795, Lalande had also registered it as a star.

May 9, 1865.—The first application of hydraulic power to machinery was due to Lord Armstrong; but its application to machine tools was due to Tweddell who, on May 9, 1865, patented a hydraulic riveter for fixing the ends of boiler tubes. In the same year he also designed hydraulic riveting plant for a Newcastle firm, enabling machine riveting to be carried out at one-seventh of the cost of hand riveting.

May 10, 1752.—Dalibard, the French botanist, was the first to draw electricity from a thundercloud. By means of an insulated rod forty feet long fixed in a stand, on May 10, 1752, when a thundercloud was overhead, sparks were drawn from the rod, leading Dalibard to write, "Franklin's idea ceases to be a conjecture. Here it has become a reality."

May 11, 1671.—On this day Nehemiah Grew's "Anatomy of Plants begun" was read before the Royal Society and ordered to be printed. It was published the following year, and later was translated into Latin, French, and Italian. In 1682 it was incorporated in the author's larger work, "Anatomy of Plants." With Malpighi, Grew shares the honour of the foundation of plant anatomy.

May 12, 1881.—In the Berlin Exhibition of 1879 an electric railway, one-third of a mile long, was shown in operation, and similar demonstration lines were installed in other exhibitions. The first permanent electric railway was that from Berlin to Lichtenfelde, which was put into operation on May 12, 1881. Electricity at 100 volts was utilised, one rail being positive and the other negative.

May 13, 1731.—After spending some years in effecting improvements in reflecting telescopes, which led to their wide adoption, John Hadley turned his attention to instruments for measuring angles, and on May 13, 1731, read to the Royal Society a paper entitled "Description of an Instrument for taking Angles." By the introduction of the use of two mirrors, Hadley was for the first time able easily to measure angles subtended by distant objects, independently of small changes in the position of the observer.

May 14, 1796.—Jenner's famous experiment in inoculation was made 131 years ago. He had long desired to try the passing of the vaccine virus from a human being to another by the ordinary mode of inoculation, and on May 14, 1796, a boy named Phipps was inoculated in the arm from a pustule on the hand of a dairymaid, Sarah Nelmes, who was infected by her master's cows. Writing a little later, Jenner said, "But now listen to the most delightful part of my story. The boy has since been inoculated for the smallpox which, as I ventured to predict, produced no effect."

May 15, 1836.—It was during the annular eclipse of the sun of May 15, 1836, that Francis Baily saw the phenomena called "Baily's Beads," of which he gave a very striking description. Though in later eclipses the "Beads" were not so vividly seen, Baily's account did much to stimulate attention to the physical aspects of solar eclipses.

E. C. S.

Societies and Academies.

LONDON.

Royal Meteorological Society, Mar. 20.—R. A. Watson Watt: The range of atmospherics (Report of the Committee on Atmospherics and Weather). The distances over which an atmospheric may produce disturbance of broadcast reception was discussed. The Committee organised experiments in which observers in the British Isles, Norway, Germany, France, Spain, Morocco, and Madeira recorded disturbance of broadcast talks, while the sources of the atmospherics were identified by radio position-finding by the organisation set up by the Department of Scientific and Industrial Research on the advice of its Radio Research Board. Many of the sources were found to lie in regions of meteorological disturbance. Atmospherics from beyond the Azores have disturbed the reception of Daventry's signals in Paris and of London's signals in Aberdeen, and a thunderstorm at Rome disturbed reception in Spain, France, Madeira, the British Isles, and Norway. Many atmospherics are heard at distances exceeding 1800 miles from their sources, and may reach at least 4500 miles. There is no evidence of the presence of many atmospherics with a short range of disturbing effect.

Geological Society, April 6.—Vincent G. Glenday and John Parkinson: The Kateruk series and associated rocks of the northern Suk Hills (Kenya Colony). A series is described of completely metamorphosed sediments which crop out on or near the Kateruk River, an eastward-flowing tributary of the Turkwal River, situated about 30° 15' long. E. and 2° 37' lat. N., in the north-western part of Kenya Colony. The rocks consist of the metamorphosed representatives of various sedimentary deposits, ashes being included. The constituents indicate a somewhat lower grade of metamorphism than those of the Turoka series of the south, and may prove to be slightly younger.—H. L. Hawkins and Miss S. M. Hampton: The occurrence, morphology, and affinities of the Silurian Echinoidea Echinocystis and Palæodiscus. Church Hill Quarry, near Leintwardine, was re-opened, and a careful record of the sediments was made. A column of rock was excavated to a depth of 12 feet 6 inches from the surface. The beds traversed are all calcareous flaggy mudstones, varying slightly in lime-content. Ripple-marked surfaces were found at two horizons. Fossils are very rare, except in congested bands. The series seems to have accumulated in shallow lagoon-water, and the indigenous fauna of echinoderms and Lingulæ was periodically reinforced by brachiopods, pteropods, and graptolites drifted in during storms. New material of Echinocystis and Palæodiscus, including specimens which show obverse and reverse casts, and others showing upper and under surfaces of the test, has made it possible to solve many of the problems associated with the genera. Echinocystis is revealed as a typical perischœchinoid, with a normal endocyclic apical system and an advanced complexity of ambulacral structure. In Palæodiscus, the indications of an endocyclic apical system seem convincing. The reputed 'Asteroid' ambulacral plates are knob-like ingrowths from the perradial zones of the otherwise normal plates. Both genera are claimed as advanced perischœchinoids—far too specialised to show pre-echinoid features.

Society of Public Analysts, April 6.—C. Ainsworth Mitchell and T. J. Ward: The sequence of strokes in writing. Systematic experiments have been made to determine to what extent one may trust to the appearance of one of two intersecting lines being

uppermost as a proof that it was made more recently than the other. The appearance coincides with the fact in the case of insoluble opaque pigments such as lead pencil, but is deceptive with a transparent pigment such as an aniline dye. The relative position of lines made with writing inks which undergo oxidation, and thus form an opaque insoluble pigment, can usually be accurately determined, but if the ink has been blotted the observation is, as a rule, untrustworthy.—D. W. Kent-Jones and C. W. Herd: (1) Observations on the washing of gluten from flour. The use of a special washing solution does not eliminate the errors inherent in gluten determinations. Even when the same amount of washing water is used and the same procedure followed, personal differences in the manipulation of the dough and gluten cause large variations in the result. Each operator, however, gets essentially consistent results, which means that the ratio between the nitrogen of the flour and the dried gluten is approximately constant for each worker. (2) A numerical expression for the colour of flour. The yellow colouring matter is extracted by means of petroleum spirit, and its colour measured in a special form of colorimeter. This figure indicates the natural whiteness, or alternatively, the artificial bleaching of the flour. The grade of the flour may be judged by the amount of the reddish-brown pigment present which, presumably, comes from the finely powdered offal. This pigment is determined in the colorimeter after extraction with alkaline methyl alcohol.—H. B. Dunncliff and Kishen Lal: The determination of free mercury in commercial products. The main constituents of the substance containing free mercury are removed by extraction with a suitable solvent. The residue is treated with bromine water, the resulting mercuric bromide is dissolved in alcohol, and the mercury is precipitated as mercuric sulphide, which is filtered off and weighed in a Gooch crucible.

PARIS.

Academy of Sciences, Mar. 28.—G. Friedel: The recent controversy between MM. Hettich and Valetton. Holoaxial hemihedral forms do not necessarily imply the hemihedry of the crystal.—Norbert Wiener: A new method for the demonstration of Tauber's theorems.—Julius Wolff: A generalisation of a theorem of H. Jentzsch.—Sugot: The gyroscopic movement of the projectile near the mouth [of the gun].—R. Mazet: The flow of a liquid starting from rest in a liquid of the same density in steady motion.—Huguénard, Magnan, and V. Sainte-Lague: The kinematographic determination of the polars in the flight of birds, gliders, and aeroplanes.—E. Carafoli: The movement round a plane plate in rotation.—Louis Breguet: Long flights without stops and the distance record in an aeroplane.—Rateau: Observations on the preceding note.—Th. De Donder: The physical interpretation of the equation of quantification of continuous systems.—Jean Jacques Trillat: The analytical interpretation of the X-ray spectra of the fatty acids and their mixtures. The same spectrum is always obtained from a pure or nearly pure acid if the preparation is made by fusion on a glass plate or by evaporation from an alcoholic solution. With mixtures of fatty acids the position of the lines cannot be predicted from the known proportions of the constituents. The study of a mixture of fatty acids fused on glass does not give the qualitative composition of the mixture, but more definite results are obtained when lead is substituted for glass.—A. Boutaric and Mlle. G. Perreau: The possibility of modifying at will the electrical sign of colloids.—Maurice Lecat: Formulæ for predicting the azeotropic constants of systems formed of an alcohol and

an alkyl halide.—René Girard: The action of complex saline solutions on the ferrous metals. With a mixture of salts in solutions, such as an artificial sea water, the net result depends on the texture of the corrosion products.—Marcel Godchot: Some syntheses of glycols containing the ether oxide grouping.—André Kling and Daniel Florentin: The hydrogenation of naphthalene and of anthracene at a high temperature and under high pressure in the presence of non-hydrogenating catalysts. Results of experiments are tabulated shewing effects, on yields and nature of hydrocarbons produced, of varying pressures of hydrogen, and also the effect of adding a catalyst.—Barré: A new method of preparing α -ketonic acids. The interaction of ethyl magnesium bromide on ethyl diethyloxamate, $C_2H_5 \cdot O \cdot CO \cdot CO \cdot N(C_2H_5)_2$, gives rise to two products, the diethylamide of α -ethyl- α -oxybutyric acid $(C_2H_5)_2 C(OH) \cdot CO \cdot N(C_2H_5)_2$, and the diethylamide of propionyl formic acid, $C_2H_5 \cdot CO \cdot CO \cdot N(C_2H_5)_2$, and the reaction can be modified to give either of these as the principal product by varying the temperature and the proportion of the magnesium compound. Propionyl formic acid can be obtained with good yields by hydrolysis of its diethylamide, and this method for the preparation of α -ketonic acids is more advantageous than those hitherto in use.—A. Wahl and Féricéan: Disulphisatide. Experiments are given proving that the double formula, $C_{16}H_{12} \cdot O_2 \cdot N_2S_2$, is more probable than the single formula, $C_8H_7 \cdot ONS$ suggested by Sander.—J. Campardou: The general preparation of hydrocarbons by the reduction of organic substances. The use of carbon and carbon monoxide. A description of a general method of reduction based on the action of carbon monoxide at 400° – 450° C., in the presence of wood charcoal as a catalyst.—A. Demay: The mylonitic zone of Grimaud and the prestephanian breaking away of the western part of the Maures massif.—Georges Mouret: The geological constitution of the Arnac-la-Poste region (Haute-Vienne).—H. Colin: The formation of sugar in the beet.—R. G. Werner: Compulsory symbiosis or independent life of the fungi of lichens.—Jacques Rollet: Histological researches on testicular grafts in mammals (white rat). The observations cited show that there is never a true graft.—A. Gurwitsch and Mme. L. Gurwitsch. The secondary mitogenetic radiation.—Ch. Achard, A. Grigaut, and A. Leblanc: The lipid equilibrium of the blood serum.

ROME.

Royal National Academy of the Lincei, Feb. 6.—G. Armellini: Horizontal diameter of the sun in 1925 and 1926. The results of three observers give for the horizontal radius of the sun at its mean distance from the earth the mean value $16' 0.63 \pm 0.04''$ for 1925 and $16' 0.09 \pm 0.04''$ for 1926, the value being $16' 1.03 \pm 0.04''$ for 1924. These results confirm the gradual diminution in the solar diameter corresponding with the maximum of sun-spots occurring in 1927–1928.—L. Petri: The presence in plants of a substance which becomes luminescent in ultra-violet light. This substance, previously noted, withstands dry heat at 170° C. but is destroyed by incineration of the plant tissues. It occurs most abundantly in those organs capable of effecting the photosynthetic assimilation of carbon and possibly constitutes a factor necessary to such assimilation, although it is not an integral part of the pigments contained in the chloroplasts. It is found in subterranean organs, but only in those which form chlorophyll if exposed to light.—M. Picone: 'Majoration' of the integrals of elliptico-parabolic linear equations with partial derivatives of the second order.—E. Bompiani: The geometry of Laplace's equation.—Arturo Cecconi:

A theorem on the work of elastic deformation.—B. Caldonazzo: An observation concerning viscous motion symmetrical with respect to an axis.—A. Weinstein: The theorem on the existence of liquid jets.—G. Rossi: Observations on the scintillation of the stars at the Royal (Italian) Observatory, Campidoglio. The phenomenon of scintillation oscillates about a mean condition in accordance with laws analogous to those governing so-called casual phenomena.—A. Carrelli: The summation theory of Thomas and Reiche.—G. Piccardi: Order number, excess weight, and atomic structure. Chemico-physical considerations concerning the relations between atomic number and atomic weight, in conjunction with astro-physical considerations, lead to the hypothesis that the excess positive and negative electrons, represented by the difference between the atomic weight of an element and twice its atomic number, are arranged outside of the atomic nucleus. It seems possible to formulate a complete theory of isotopes on this foundation.—G. R. Levi and A. Reina: Peptisation of 'meta' thorium oxide. Investigation of the process of peptisation of thorium oxide by X-ray analysis shows that the 'meta' variety of this compound has a distinctly higher degree of subdivision than the ordinary product, and that this process involves no further subdivision of the separate crystalline granules and no increase of the interatomic distances.—G. Bozza and G. Devoto: Calculation of the chemical affinity on the basis of entropy.—G. Ponte: Temperature of laval percolations from Etna. Consideration of the observations recorded by previous investigators indicates that the temperature in the bed of the flow of a stream of lava is transmitted slowly and may rise considerably in the central part where the movement is greatest, that is, where fresh hot lava is continually arriving. The extent of the cooling at the surface naturally depends on a number of factors.—P. Principi: Miocene strata between the valleys of the Lamone and Bidente.—D. Rosa: A possible variant of hologenesis.—Darwin Wen: New experiments on the hereditary behaviour of the capacity of the egg for development. Parthenogenesis in crosses between uni- and bi-voltine races of *Bombix mori*.—G. Cotronei: The systematic biology of *Petromyzon*.—U. D'Ancona: Growth of the Tiber shad. The curve representing the length of this fish in relation to its age resembles a parabola, whereas the weight-age curve is analogous to that representing autocatalytic reactions according to Robertson's equation, $\log x/A - x = K(t - t_1)$. Hence, the value of k in the equation, $P = kL^2$, where P is the weight and L the length, varies with the age. The growth in length varies during different months of the year in a manner represented approximately by a sinoidal curve, which is superposed on the parabola showing the annual growth. The growth in weight also exhibits oscillations with an annual period, the amplitude being small before the attainment of sexual maturity, and considerable afterwards.

VIENNA.

Academy of Sciences, Mar. 10.—H. Mache: Nernst's heat theorem and the impossibility of attaining absolute zero.—A. Kieslinger: (iii) The stone-ovens (*Steinöfen*) of the Kor Alp region; (iv) Old and young disintegrations in the Kor Alp region.—H. Herrmann: The behaviour of frog's lymph towards blood of another species.—J. Pollak, K. Deutscher, and M. Krauss: The course of Leuckart's xanthogenate reaction.—E. Blumenstock-Halward: The action of aqua regia on fluorine.—O. Lustig and E. Katscher: The action of chlorosulphonic acid on aromatic amines.—J. Warkany: (i) The problem of the

destruction of lactic acid by erythrocytes; (ii) The methods of determining lactic acid in urine.—J. Lense: A contribution to the geometry of the sphere.

Mar. 17.—F. Quittner: The electrolytic conductivity of glass at high voltages.—L. Moser and M. Niessner: The determination and separation of rare metals: (ix) Beryllium from aluminium. Aluminium can be precipitated along with ferric hydrate, which acts as a flocculating agent. Replacing iron by tannin, the tannin can be used to bring down the aluminium, whilst ammonium acetate retains the beryllium in solution as a complex salt.—H. Neudorfer: The analysis of the principal tangent curves on algebraic net-surfaces.—A. Smekal: Further investigations on deformed crystals of rock-salt.

Official Publications Received.

BRITISH.

Memoirs of the Geological Survey of India. Palaeontologia Indica. New Series, Vol. 10, Memoir No. 1: Palaeozoic and Mesozoic Fossils from Yun-nan. By Dr. F. R. Cowper Reed. Pp. iv+331+vi+20 plates. (Calcutta: Government of India Central Publication Branch.) 20.9 rupees; 32s.

Report of the Kodaikanal Observatory for the Year 1926. Pp. 4. (Calcutta: Government of India Central Publication Branch.) 6 annas. University of Glasgow. Reports on the Hunterian Collections for the Year 1925-26. Pp. 7. (Glasgow.)

The Half-Yearly Journal of the Mysore University. Vol. 1, No. 1, January. Pp. 92. (Bangalore.) 2 rupees

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 14, No. 3: Sugarcane Breeding—Indications of Inheritance. By Rao Sahab T. S. Venkatraman. Pp. 113-120+6 plates. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10s.

Rhodesian Museum, Bulawayo. Twenty-fifth Annual Report, 1926. Pp. 15. (Bulawayo.)

The Snake Park, Port Elizabeth. By F. W. FitzSimons. Pp. 32. (Port Elizabeth: Port Elizabeth Museum)

Institution of Chemical Engineers. Some Industrial Developments and the Chemical Engineer. Presidential Address by Sir Frederic L. Nathan delivered at the Fifth Annual Corporate Meeting of the Institution of Chemical Engineers, held at the Hotel Victoria, London, W.C.2, 11th March 1927. Pp. 7. (London)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 83: The Maintenance Requirements of Cattle on Different Rations and at Different Rates of Production; with a Note on 'Dynamic Action,' By James Wilson. Pp. 399-406. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

Annual Report of the Auckland Institute and Museum for 1926-27, adopted at the Annual General Meeting held on 7th March 1927. Pp. 29. (Auckland, N.Z.)

Transactions and Proceedings of the New Zealand Institute. Vol. 87. Pp. x+1123+80 plates. (Wellington, N.Z.)

New Zealand: Dominion Museum. Bulletin No. 8: Games and Pastimes of the Maori; an Account of various Exercises, Games and Pastimes of the Natives of New Zealand, as practised in former Times; including some information concerning their Vocal and Instrumental Music. By Elsdon Best. Pp. viii+191+67 plates. (Wellington, N.Z.)

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Arboricultural Society. Vol. 41, Part 1, March. Pp. x+104+39. (Edinburgh: Douglas and Foulis.) 3s.

FOREIGN.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 3: Vattenståndet vid Rikets kuster. Pp. ii+21. (Stockholm.) 2 kr.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 10: Sur la structure thermique de l'atmosphère au-dessus de la Suède méridionale; sondages faits par avion en 1924 et 1925. Par F. Lindholm. Pp. 42. 2.50 kr. Band 3, No. 11: De svenska vattendragens arealförhållanden. 4: Piteälvs m.f. Av Gustaf Wersén. Pp. 16. 1.50 kr. Band 3, No. 12: Recording Nocturnal Radiation. By Anders Ångström. Pp. 12. 1 kr. (Stockholm.)

U.S. Department of Agriculture: Weather Bureau. Monthly Weather Review, Supplement No. 28: Climatological Data for the Tropical Islands of the Pacific Ocean (Oceania). By W. W. Reed. Pp. iii+22. (Washington, D.C.: Government Printing Office.) 10 cents.

General Guide to the Exhibition Halls of the Peabody Museum of Natural History, Yale University. Prepared by the Curators, edited by Clara M. LeYene. Pp. 54. (New Haven, Conn.) 25 cents.

Astronomical Papers prepared for the Use of the American Ephemeris and Nautical Almanac. Published by the Nautical Almanac Office, U.S. Naval Observatory, by direction of the Secretary of the Navy and under the Authority of Congress. Vol. 9, Part 3: The Orbit of Neptune's Satellite and the Pole of Neptune's Equator. Pp. ii+275-337. (Washington, D.C.: Government Printing Office.)

University of California Publications in American Archaeology and Ethnology. Vol. 22, No. 3: Washo Texts. By Grace Dangberg. Pp. 391-443. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 65 cents.

Bulletin of the National Research Council. Vol. 11, Part 3, No. 57: Molecular Spectra in Gases. Report of the Committee on Radiation in Gases. Pp. 353. (Washington, D.C.: National Academy of Sciences.) 4 dollars.

Department of the Interior: Bureau of Education. Education in the United States of America. Prepared under the Direction of Jno. J. Tigert for the Pan Pacific Conference on Education, Rehabilitation, Reclamation and Recreation, Honolulu, T.H., April 11 to 16, 1927. Pp. v+75. (Washington, D.C.: Government Printing Office.) 20 cents.

International Hydrographic Bureau. List of Lifesaving Stations of the World, with their Equipment and Geographical Positions: Liste des Stations de sauvetage du monde entier, avec leur équipement et leurs positions géographiques. By Rear Admiral A. P. Niblack. (Special Publication No. 18.) Pp. 82. (Monaco) 30 cents.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin statistique des pêches maritimes des pays du nord et de l'ouest de l'Europe. Vol. 14, pour l'année 1924. Pp. 51. Rapports et procès-verbaux des réunions. Vol. 41: Procès-verbaux (Septembre 1926). Pp. 209. (Copenhagen: Andr. Fred. Host et fils)

CATALOGUE.

Classified List of Second-hand Scientific Instruments. (No. 90.) Pp. vi+58. (London: C. Baker.)

Diary of Societies.

SATURDAY, MAY 7.

ROYAL SOCIETY OF MEDICINE (Otolaryngology Section) (at 1 Wimpole Street, W.), at 9.15 A.M.—Annual General Meeting.

BIOCHEMICAL SOCIETY (In Physiology Department, Manchester University), at 8.—Kathleen Culhane and Dr. G. W. F. Underhill: Variations in the Serum Calcium of Rabbits.—F. C. Hapgood: The Attempted Isolation of a Type Precipitinogen from *D. aertrycke*, Mutton.—P. W. Clutterbuck: Experiments on the Origin of Succinic Acid in Muscle and Liver.—C. E. M. Pugh and Prof. H. S. Raper: The Action of Tyrosinase on Phenols.—E. Boyland and A. D. Ritchie: Chemical Changes in Muscle.—J. Pryde and J. M. Peterson: The Carbohydrate-phosphate Component of Animal Nucleic Acid.—J. Pryde and E. T. Waters: Some Observations on Methylated Glycerophosphatide.—T. K. Walker and P. D. Coppock: Fermentation of Propionic Acid by *Aspergillus niger*.—Ellen Stedman and E. Stedman: Haemocyanin. Part IV. The Dependence of the Shape of the Oxygen Dissociation Curve on the State of Ionisation of the Protein.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District) (at Grand Hotel, Dover), at 4.—J. A. Jarvis: Notes of the Earlier Housing Schemes of the Corporation.—W. Bryan: Notes on Housing in the Tower Hamlets District of the Borough of Dover.—F. V. How: The Pier District Improvement Scheme, Dover.—W. B. Smith: Dover—Notes on Recent Municipal Activities.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 4.—E. Longden: Some Aspects of Foundry Work.

MONDAY, MAY 9.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. D. Noel Paton: Submergence and Postural Apnoea (Cessation of Breathing) in the Swan.—Prof. H. G. Cannon: On the Feeding Mechanism of *Nebalia Bipes*.—A. H. R. Goldie: The Structure and Movement of the Atmosphere as affected by Diurnal Variations.—To be read by title.—Dr. A. W. Greenwood and Dr. F. A. E. Crew: On the Quantitative Relation of Comb Size and Gonadic Activity in the Fowl.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Miss Hilda D. Oakeley: The World as Memory and as History.

ROYAL SOCIETY OF ARTS, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (3).

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 8.—Mrs. Susan Isaacs: The Function of the School for the Young Child.

SURVEYORS' INSTITUTION, at 8.—A. M. Trustram Eve and others: General Discussion on The Practical Application of the Rating and Valuation Act, 1925.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Plymouth).

TUESDAY, MAY 10.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) at 5.—Annual General Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. R. Broom: On Sphenosuchus, and the Origin of the Crocodiles.—Dr. H. H. Scott: (a) Neoplasm in an Indian Rhinoceros; (b) Two Cases of Peritoneal Neoplasm (Endothelioma).—C. A. Hoare: Schewiakoff's Keys for the Determination of the Holotrichous Ciliates.—Dr. F. P. Stowell: The Resistance of certain Metals and Metallic Alloys to Corrosion and Solution by Sea-water.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—H. J. Young: Some Metals and Methods of Use in Marine Engineering.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—A. S. Newman: Inertia Momentum.—A. J. Griffin: The Care of Kiné Negative during Development.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. D. Ward Cutler: The Effect of External Conditions on Soil Micro-organisms.

WEDNESDAY, MAY 11.

ELECTRICAL ASSOCIATION FOR WOMEN (Annual Meeting) (at Hotel Cecil), at 11.30.—At 8.30 (at Magnet House, Kingsway).—Lecture on Refrigeration and the Pure Food Act.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology) (Annual General Meeting), at 5.—Prof. B. Miles, W. B. Gabriel, and others: Discussion on Colostomy.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. P. G. H. Boswell: The Salopian Rocks and Tectonics of the District South-West of Ruthin (Denbighshire).—R. C. Blackie: The Geology of the Country between Manafelan and Bryneglwys.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. E. Dalby: English Railways (Lectures) (2).

INSTITUTE OF METALLURGISTS (at Institution of Mechanical Engineers), at 8.—Sir Henry A. Heffer: The Growth of Crystals in Supersaturated Liquids (Annual May Lecture).

EUGENICS SOCIETY (at Royal Society), at 8.30.—Miss Evelyn Lawrence: Intelligence of Institution Children.

THURSDAY, MAY 12.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Discussion on The Function and Distribution in Living Organisms of Haemoglobin and Related Substances. Speakers: Prof. J. Barcroft, Dr. H. Hartnidge, Sir Frederick Hopkins, Dr. D. Keilin, F. J. W. Roughton, R. Hill, Prof. H. M. Fox, Dr. J. B. S. Haldane.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. H. F. Baker: Geometry and Differential Geometry (Lecture).

BRITISH SCIENCE GUILD (Annual Dinner) (at Criterion Restaurant), at 7.30.—Speakers: Sir Alfred Mond, Bart., Sir Herbert Samuel, Gen. Sir George F. Milne, Hon. W. Ormsby-Gore, Sir William Pope, Sir Frederick Keeble, Rev. Prebendary Gough.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. M. von Rohr: Note on the History of English Opticians in the First Half of the Nineteenth Century (with special reference to Spectacle History).

INSTITUTION OF STRUCTURAL ENGINEERS (at 10 Upper Belgrave Street, S.W.), at 8.—A. G. Pugsley: Some Problems in the Design of Steel Roof Truss Members.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Annual General Meeting) (at 8 St. Martin's Place, W.C.), at 8.—A. de Waele: Some Physical Factors influencing Properties of Paint Pigments.

FRIDAY, MAY 13.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science and Technology), at 2.30.—Plant Alkaloids.—Lieut.-Col. A. T. Gage: The Principal Plants yielding Alkaloids.—Dr. T. A. Henry: The Biochemistry of the Alkaloids.—Dr. J. Trevan: The Medical Aspects of the Alkaloids.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. H. Chatley: The Stability of Dredged Cuts in Alluvium.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Humphry Rolleston, Bart.: Concerning Old Age.

SATURDAY, MAY 14.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

SUNDAY, MAY 15.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

PUBLIC LECTURES.

SATURDAY, MAY 7.

OXFORD UNIVERSITY, at 12.—Sir John Simon: The Labrador Boundary.

SUNDAY, MAY 8.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Ancient Civilisations.

TUESDAY, MAY 10.

KING'S COLLEGE, at 5.30.—Prof. A. Michotte: Problems of Mental Work. (Succeeding Lectures on May 12 and 13.)

ROYAL SCHOOL OF MINES, at 5.30.—Dr. F. F. Blackman: Problems of the Respiration of Plants. (Succeeding Lectures on May 17 and 24.)

UNIVERSITY COLLEGE, at 5.30.—W. H. McLean: National, Regional and Town Development Planning. (Succeeding Lectures on May 17, 24, and 31.)

GRESHAM COLLEGE (Basinghall Street, E.C.), at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on May 11, 12, and 13.)

THURSDAY, MAY 12.

UNIVERSITY OF BIRMINGHAM (Faculty of Medicine), at 4.—Dr. F. A. E. Crew: Organic Inheritance in Man (William Withering Memorial Lectures). (Succeeding Lectures on May 19, 25, 26, June 1 and 2.)

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Dr. R. A. O'Brien: Streptococci—their Toxins and Antitoxins.

FRIDAY, MAY 13.

UNIVERSITY COLLEGE, at 5.30.—Prof. J. Burnet: Platononic Problems. (Succeeding Lectures on May 20 and 27.)—At 8.30.—Sir John Rose Bradford: University College, London, and Medical Education (Centenary Celebrations Address).

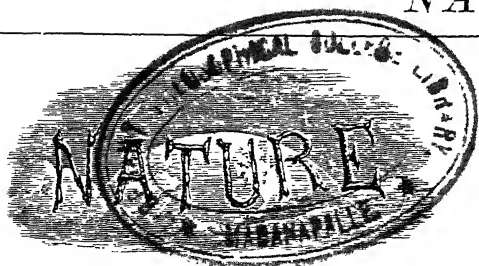
SUNDAY, MAY 15.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Dr. D. G. Hogarth: The Hittite People and their Civilisation.

CONVENTION.

JUNE 6 TO 9.

CONVENTION OF CANADIAN CHEMISTS (at Quebec).



SATURDAY, MAY 14, 1927.

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British Settlement in the Dominions Overseas.

THE various schemes which were formulated just before the War to alleviate the hardships of the indigent workless and destitute and to provide for their old age had an immediate retarding effect upon emigration from the United Kingdom. The majority of emigrants are manual workers, and anything which makes for their greater security in Great Britain must increase their natural reluctance to become the sport of chance circumstance in other lands. But the empty spaces of our vast dominions must be peopled, and it is held that it is best they should be peopled by our own stock. With this object in view the Empire Settlement Act was placed on the Statute Book in 1922, to enable the Home Government, in association with the government of any part of His Majesty's Dominions, or with public authorities or public or private organisations, to formulate and co-operate in schemes for development or land settlement, and for facilitating settlement in or migration to our dominions by assistance with passages, initial allowances, training, or otherwise.

The Committee appointed to carry out these schemes has just presented to Parliament a report for 1926.¹ The total number of persons assisted under the Empire Settlement Act increased from 39,559 in 1925 to 66,103 in 1926, or rather more than two-thirds of the total number of emigrants to the Dominions and more than half the net movement of population from Great Britain. The numbers assisted to Australia and New Zealand show increases of 10,205 and 3698; while the numbers assisted to Canada have risen from 8809 in 1925 to 21,344 in 1926. The Committee states that out of a net movement from Great Britain in 1926 of 115,538 persons, 93,227 went to homes within the Empire, a gratifying proportion. If this number of emigrants is maintained for the next few years, the average will be considerably above that for the decade 1901 to 1911, when it averaged 76,000 persons a year. Yet, as the Committee points out, the net movement from Great Britain overseas represents only two-fifths of the natural increase in our home population. If it is a fact, therefore, that Great Britain is already overcrowded, and, as many think, that under our present system we cannot keep all our people who are willing to work employed, the need

¹ Report of the Oversea Settlement Committee for the Year ended 31st December 1926. (Cmd. 2847.) Pp. 30. (London: H.M. Stationery Office. 1927.) 6d. net.

for a greatly accelerated movement of our home population overseas is a matter of supreme urgency.

It is interesting to find that Australia absorbs more than half the migrants within the Empire. It seems reasonable that Australia should be preferred to Canada, but it is a little difficult to understand why New Zealand does not attract more settlers: it is a lovely and varied land, with a delightful climate and abundant natural resources. The Committee offers no explanation; neither are we informed in the report why so few British migrate to South Africa: only 126 went there in 1925 and 232 in 1926. The great increase in the number migrating to Canada is to be explained by the liberal arrangements made for their reception and settlement, including what appear to be generous terms for capital advances.

The subject of migration is important enough to warrant a much more comprehensive account of the work of the Oversea Settlement Committee than that which has been vouchsafed in this report. But the subject is dismissed in 16 pages, most of which are filled by rather vague generalisations, interspersed with quotations from other Government publications. Most of the vital statistics contained in the report are given above. A little information, it is true, is to be found in the four appendices which fill the last 11 pages of the report. Yet many aspects of the problem upon which it might be assumed members of Parliament would wish to be informed are not dealt with at all. No reference is made as to the proportion of British to other European immigrants to the Dominions, or to the assistance given by other nations to their emigrants. The tide of emigration from central and southern European States, in many of which the standard of living of the working classes is appallingly low, has an important bearing upon the overseas settlement of our own people. No attempt is made to deal with the economics of migration. If information is desired on this aspect of the subject, it must be culled from the biased and often unsubstantiated statements of overseas statesmen, or from the handbooks issued by the various shipping agencies, any of which, it must be confessed, are more informative than this official report. Yet there is much information to be gathered from an examination of our trade returns. Each family settled in Australia, for example, creates a demand for our home products the value of which is roughly equivalent to the amount required to maintain a family at home. If satisfactory arrangements could be made to transfer 20,000 families yearly

to Australia, our own unemployment problem would be quickly solved.

There are other omissions. No information is given regarding the relative suitability of the various parts of the Dominions for settlement, or what are the principal crops raised or the markets they serve. Nothing is said regarding the terms on which land is granted: prospective emigrants will look in vain for information regarding the provision of the amenities of life to which they are accustomed at home, for example, education and health services, housing, transport, and communications. No indication is given of the return which can be expected from arable or mixed farming, or what are the prospects for pastoralists, based upon the purchase price of available land, the cost of domestic stock, and the cost of living.

The most serious omission, however, is in connexion with the movement of the rural populations of the Dominions towards the towns. It is well known that the urban populations of the Dominions are increasing far more rapidly than the rural populations. The percentage increase of the urban population of Australia in the decade 1911-1921 was approximately 36, whereas the increase of the rural population in the same period was less than 9 per cent. It is a striking fact that the ratio of 'primary producers' to other classes in Australia—an agricultural country—is appreciably smaller than the corresponding ratio for Great Britain—a highly industrialised community. It is sometimes urged that our education system in Great Britain is at fault for failing to make rural life more attractive than life in our large cities: and the criticism is just. With equal justice it could be urged that Australia has not yet come to grips with the same problem. The Australian town-dwellers realise their success mainly depends upon a growing number of agriculturists, and they are prepared to support any scheme which will attract agricultural settlers from Great Britain, just as ardently as they will oppose the indiscriminate transference of our urban population to their towns; but they fail to realise, apparently, that the flight from the land can be retarded or arrested only by complete re-orientation of their education system coupled with profound modifications of their economic policy.

It would be interesting to know from which classes of the home community overseas settlers are drawn, and it should not be difficult to include such an analysis in a report of this kind. In the summary of Lord Clarendon's report on his visit to Canada, it is stated: "Possibly somewhat too

strong a preference may have been shown for families with farm experience. Inexperienced families, if they have the right spirit, seem to succeed just as well as the experienced. . . . Families from the coal-mining districts of Great Britain appear to show as good an average of success as any other families settled under the scheme." An authoritative statement of this kind is of the utmost importance, but it would carry even greater weight if it were backed up by statistical evidence. Even such a qualitative statement, however, should do much to break down the prejudice of selection committees against offering inducements to urban workers to settle on the land in our Dominions. What the urban worker lacks in experience in comparison with the farm-worker is offset by his greater adaptability to new conditions, an adaptability born of a higher intellectual standard. Rural education in Great Britain is still in a backwater.

The Committee states that it is "conscious of the closeness of the relationship between research, development, and settlement." It would be interesting to know what kind of research the Committee has in view, what are the problems which face the Dominions for which no solution can be found on the basis of knowledge already available. Unquestionably there are vast fields of inquiry in which research workers may labour. But the Saul-like conversion of our imperial statesmen to the new faith in scientific research must not blind them, any more than the members of the Oversea Settlement Committee, to the fact that settlement and development schemes can be based upon existing knowledge. The immediate need is for a comprehensive survey of the accessible and potential resources of the Empire, an Empire stocktaking, in fact, upon which all sound schemes of overseas settlement and research should be based.

It is to be hoped that in its next report the Committee will make a real attempt to deal with the problem of re-distribution of population in a scientific spirit. There are a number of diverse contributory factors to be taken into account in an inquiry of this nature, most of which appear to have been completely ignored hitherto. The report, in fact, constitutes a slight on the members of Parliament to whom it is made. It implies either that they do not possess the intelligence to examine the problem of migration of peoples thoroughly, or that they have very little interest in a subject of vital importance to the whole of the advanced peoples of the world.

The Numerical Measurement of Genius.

Genetic Studies of Genius. Edited by Lewis M. Terman. Vol. 1: *Mental and Physical Traits of a Thousand Gifted Children.* By Lewis M. Terman and others. Second edition. Pp. xiii+648. Vol. 2: *The Early Mental Traits of Three Hundred Geniuses.* By Catherine Morris Cox, assisted by Lela O. Gillan, Ruth Haines Livesay, and Lewis M. Terman. Pp. xxiii+842. (Stanford University, Cal.: Stanford University Press: London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1926.) 21s. net each vol.

IT is only when one studies a vast American work like this—which in its first two volumes covers more than 1500 pages, with still more volumes to come—that one realises that America is not Europe, that American science, for good or bad, is obtaining an individuality of its own, and that there is some hope that a population, which anthropologically is probably the most mixed the world has ever experienced, will shake down and ultimately develop national mental, if not national physical, characteristics. America has had many difficulties to contend with; it is not usually the ablest races who emigrate, still less is it the ablest members of those races. For early emigrants also, good physique rather than strong mentality is the essential factor of success. Occasionally, as in the case of Dutch and Huguenot immigrants to England, some political or religious movement drives a better class of men to change their homeland. But the bulk of men who have colonised America, especially of recent years, are men who were not succeeding very well in Europe, and hoped to find in spacious America more room for a return for their hard labour. The very spaciousness of America has been one of its disadvantages. It was possible to *acquire* with relatively little effort; there was no need to preserve or to maintain past acquirements, whether mental or physical; property and tradition were of smaller value than in older and more crowded countries. There was no natural selection of physique or ability, because inferiority had merely to go farther westward, where ease of acquirement increased with every degree of longitude. The alternation from pauper to millionaire was as rapid as the reverse process, for to acquire was so simple that few learnt to conserve.

To most of us who think anthropologically, there is small wonder that America thus far has not been prolific in genius. In Vol. 2 of the work under

discussion we find sixteen American men of genius enumerated. Six were presidents (Grant, Jackson, the two Adamses, Lincoln, and Washington), two men of the sword (Farragut and Sherman), four statesmen (Franklin, Hamilton, Seward, and Webster), and four authors (Longfellow, Washington Irving, Emerson, and Prescott), all dying in the century 1790–1890, and all known to every educated European. But would a Frenchman or a German have included more than two or three of these in a list comprising Galilei, Newton, Laplace, Darwin, Shakespeare, Goethe, Molière, Voltaire, Rousseau, Heine, Byron, Spinoza, Descartes, Dürer, Raphael, Titian, Mozart, Bach, *et hoc genus*? These are men of creative imagination, world-shakers, who have set their seals upon human culture, and if only 282 men of genius are to be taken for the four centuries 1450–1850, a sense of proportion might have hindered a European scientific writer from allotting 16 to America in one century!

The Americans are a young people; it will not be possible to call them racially a nation until far more intermarriage has taken place among their component groups, and more intense selection has been called into play; then will come national individuality, and then no doubt also new and typical forms of genius. Were a genius to arise to-morrow in America, whatever his class, one to be reckoned respectively with the six greatest scientific workers, scholars, painters, or authors of the world, he would be an offspring of the Old World, a German, an Englishman, or a Jew, not only racially, but also in modes of thought. Yet the day will indeed come, if not yet, when the typical American genius will appear. Can it be hastened by such a work as we have now under notice?

The scheme attempted is undoubtedly a great one, one that could only be imagined by a youthful people without the heritage—or shall we say bondage?—of formed traditions. It proposes first to determine how much in the genius of the past is due to (a) heredity, (b) native endowment, and (c) training; then to discover the gifted children in the American population, and give them the training appropriate to genius. One of the striking points in this novel scheme is that the authors venture to preach in a great democracy the doctrine of caste, that ability runs in families, that not only are gifted children born from superior parents, but also that those parents have superior traditional culture and follow higher-class occupations.

Before we can determine, however, what the
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'gifted child' signifies to American psychologists, we must appreciate how he is to be selected. One of the difficulties of examinational selection of mental characters lies in the differentiation of acquired knowledge from mental facility or general intelligence. The former is partly a matter of age and partly a matter of home environment. To surmount the age difficulty the Binet-Simon tests were devised; they provided a system of tests suited to the average child of each year of life, but even with these it is difficult to ensure that success in passing may not be correlated with home training. The year-tests which a child could just answer gave its mental age, and, on the suggestion of Wilhelm Stern, the ratio of mental age to chronological age provided a measure of intelligence which might be taken as independent of age. This so-called 'intelligence quotient' has been developed—especially in America—in an immense variety of ways. The original Binet-Simon mental age tests have been altered, adapted, varied until almost every American university, if not every psychological teacher therein, has an individual series of tests. At the present moment, from west to east, from north to south, the American population is being psychologically tested. Universities, schools of all classes, prisons, reformatories, homes for the mentally defective and for fallen women, orphanages and training camps are being examined for their intelligence quotients. The climax was reached in the War, when the whole American Army was psychologically tested. Its average mental age was, if we recollect rightly, just fifteen years! What is quite certain is that English public schoolboys and English undergraduates would only treat as a joke the questions put to their American confrères to test not only their intelligence but also their interests, their moral and their religious senses, their sociability and their personality traits. If we are to trust the mass of papers resulting from these tests, the schedule scatterer must have an easier time in new America than he would have in the Old World!

However, starting with a teacher's selection, followed by a Stanford-Binet psychological test, some 600 boys and girls have been selected out of some quarter of a million of the Californian school children. These are the 'gifted' children from whom we are to expect genius. They and their parents have then been examined in almost every conceivable manner after selection. Their parents have been requested to fill in 'blanks' not only with regard to their children but also with regard to themselves. Anthropometric examinations,

medical examinations, 'interests' examinations, character and personality traits examinations, etc., have been organised to an astonishing degree. We know now whether a Californian gifted boy likes to collect insects or tram tickets, whether he would like to be a statesman or a Christian Science healer, whether he always remembers to clean his teeth, whether he ever dreams of people being dead, whether he can keep still on being tickled; these are a few among some 85 similar questions!

But we feel some hesitation even yet. Is not real genius inert to all examinations, even to a psychological one? May not the one real genius that California may very likely produce in the next half-century have slipped through the meshes of this intelligence quotient net? Unfortunately, there is no adequate control series being followed up through life in the same way, and if another 600 not gifted, but mediocre, children were being pursued in like manner, would an isolated genius in one or other series prove anything at all? We should be able possibly to judge whether the gifted children had or had not done better in life, but the fact that one had taken a Ph.D. degree and become an academic instructor, that another had completed his work for an Sc.D. degree or gone to Europe for study, might only be the effect of the home environment selected by the sort of questions set in the intelligence test. Statistically also, when we divide into sexes, and allow for deaths before achievement, and for the probable disappearance otherwise of many individuals, the numbers, we fear, may ultimately be found quite inadequate.

As for the statistical treatment of the data, it can only be said to be moderately satisfactory. For example, Dr. Lenz's criticisms on the original Terman treatment of the size of family in the case of families with gifted children are taken as truth without apparently any further examination; but in the case of a family of eight or ten children whose births may be extended over a period of fourteen or sixteen years, it is not equally probable that all the children will be found at school at the same time, and Lenz's method of correcting fertility is fallacious, and therefore Terman's conclusions drawn by applying it appear to be incorrect. Again, in the fundamental table on p. 41 and in the "corrected" table, p. 44, no comment is made on the large correlation of intelligence quotient with age (correlation ratio of quotient on age is of the order 0.37), and yet this is certainly a matter which deserved ample treatment. The method of correction detailed in a footnote is, we venture to think, obscure, and the diagrams are

not adequately elucidated. Many other points will occur to the mathematically trained statistician on reading the work.

Still, we would not appear ungrateful for the labour which the collection of such an immense amount of data—of varying grades of usefulness—must have involved. In the course of the next thirty or forty years we may know whether the grading of children by aid of their intelligence quotients is correlated with their success in after life. That may not be without value and scientific interest, but we may reasonably ask whether it could not have been better accomplished by following up an additional 600 children with low intelligence quotients rather than by piling up *questionnaires* on the first group. That we are, by the study of these high intelligence quotient children, on the path to determine anything about the genetics of or the suitable training for 'genius,' frankly, we do not believe.

We might think that the word 'genius' is understood in a different sense in Europe and in America, but when we turn to the second volume of these "Genetic Studies of Genius," we find that in the abstracts of the "Early Mental Traits of Geniuses" (which occupy some 600 out of the 800 pages of this volume), the bulk of the individuals included are those that a European would classify in the same way. Yet if 'genius' be one in a million—are there indeed 10 male geniuses in England at this moment?—what hope is there of those 352 'gifted' Californian children throwing light on the matter? However, Miss Catherine Cox accepts the European estimate, if with some patriotic bias. How, then, are these accounts of the early intelligence and early environment of genius to be brought into relation with the gifted children of California? Only if we can assign by the accounts we have of the childhood of genius—*i.e.* on the basis of biographies—the corresponding intelligence quotients!

Now the great merit of the Binet-Simon tests arises from the fact that they give a numerical value to the living child by aid of direct experiments. It appears to the present reviewer that when the psychologist turns the matter inside out and says that he has had such experience of these tests and of young children that he can measure the childish 'brilliance' of genius as reported in dictionaries of biography by means of allotting intelligence quotients, he is standing as a scientific worker on a very dangerous slope indeed. Here again we have no control series, which would have to be from as many nations as the men of genius are

selected from. Yet without such a series, how can we judge the precocity, the 'brilliancy' as our author terms it, of these nationals? In the case of great men, every scrap of their handwriting has been sought for and often preserved; in the case of mediocre men, it goes into the waste-paper basket when their mothers die. Erasmus is given an intelligence quotient of only 135 before seventeen years age. What would it have been had his school scribbles been preserved? Benjamin Franklin is given one of 145, because we have his autobiography and know of his childhood. James Stuart Mill is given an intelligence quotient of 200, not because he was ever natively brilliant, but because his apt intelligence was reared in a forcing house by James Mill; and how old-fashioned would now be the economist who would even admit James Stuart Mill to a place among the 282 men of genius of four centuries in Europe! Galton as a child is given an intelligent quotient of 200, because his biographer included certain letters from his childhood in his *Life*; Darwin as a child is given an intelligence quotient of only 135, because his biographer had not, or did not think fit to print, any such letters. Newton as a child is measured by 130, but Leibnitz as a child by 185. Shakespeare cannot be rated at all, because nothing of his childhood has been preserved for us. What would such ratings be worth if they were not, as they actually are, guesses? They depend entirely on the amount and character of the material which has been preserved for forming an estimate; they depend on the nation to which the man of genius belonged. They can tell us nothing of the extent to which relative achievement in later life depends upon relative childish 'brilliancy.' With Defoe, Linnaeus, Napier, Harvey, and John Locke as children at 125, and Klopstock, Wieland, and Longfellow at about 150, what can we learn from this modern psychological guessing based on biographical dictionaries?

Our author prefaces her work with much talk about the value and accuracy of 'historiometric' methods of investigation; she gives various mathematical investigations of the exactness of the process of guess-work involved and of her methods of 'correcting' her numerical estimates. Some of this is very open to question from the mathematical side. We do not base our main criticism on that, but on these two indubitable facts: first, that she has no control series of the mediocre men of the various nations through these centuries, and secondly, that the estimates of her colleagues and herself, even if accurate, depend entirely on the

amount of data known, or at least cited in the biographical dictionaries. How would the intelligence quotient of Newton as a boy be modified by the discovery of his diary, or the knowledge that his mother sprung from an illustrious family? How would Nelson's 125 as a child be modified had the writer known that his mother was descended from the Walpoles, one of the English families most noteworthy for administrative ability?

Do we consider then that this volume is a waste product of several years' work? Not in the least. We know no book that so satisfactorily condenses the main facts with regard to the boyhood of great men. Its usefulness will survive long after the intelligence quotients which are scattered through its pages have ceased to be regarded. Is this the judgment of a European? Very possibly. The fact that it becomes more and more difficult for the European to grasp and judge modern American scientific work may be rather evidence of the European's conservatism than of the naïveté of that work itself. America is not, but is becoming, a nation, and, as we all know, nations with the very best intentions fail to understand each other. Youth too often fails to interpret itself to age.

Chinese Agriculture.

Die chinesische Landwirtschaft. Von Dr. Wilhelm Wagner. Pp. xv + 668. (Berlin: Paul Parey, 1926.) 42 gold marks.

THE agricultural methods of China have long excited the interest and curiosity of Western experts, partly because they are highly intensive and partly because of the element of mystery still surrounding all things Chinese. On western methods, 2-2½ acres of land are required for the maintenance of each person; but there are great areas in China where two acres of land support no less than five people, to say nothing of a donkey and other animals. The comparison is striking, even allowing for the great difference between eastern and western ideas of maintenance.

Hitherto, and in spite of its inherent interest, Western experts have had little opportunity of learning anything about Chinese agriculture. There are a few articles in the *Chinese Repository* and in Millard's "Review of the Far East," not usually available in agricultural libraries, but no account by any English writers except the useful summary in the "Encyclopædia Britannica." The only accessible account hitherto has been that written by the late F. H. King, the well-known

soil physicist of Wisconsin, who visited the Far East in 1910 and recorded his impressions in his book, "Farmers of Forty Centuries."

Dr. Wagner had therefore almost a clear field when he undertook to describe Chinese agriculture. His qualifications for the task are considerable; he was appointed as agricultural lecturer in 1911 to the High School set up by the Germans in Tsingtau for the education of the Chinese, and he remained in China until 1920. When he began, the school was only two years old, and the agricultural equipment, he tells us, was a blackboard, a sponge, and a piece of chalk; by August 1914, laboratories had been erected and the institution possessed 16 hectares of experimental farm land and proper farm buildings, with more than 30 head of cows and 5 horses in addition to pigs and other animals. His students came from various parts of China, and he had many opportunities of learning about its agriculture.

The plan is to discuss first of all the natural conditions, particularly climate and soil, then the human factors, finally the methods of dealing with the soil and its chief crops.

The author adopts the usual divisions of China into a northern and a southern section separated by a folded range of the Tsing-ling-shan. The northern part is subdivided into the western highlands, often desert and sparsely populated; and the eastern plain of yellow loess soil, entirely agricultural and densely populated. The south is somewhat similarly divided, but the soil is not loess; it is largely sandy or calcareous. Again, however, the east is the agricultural land with the dense population. The river valleys are highly fertile, but even the hills are cultivated, being laid up in terraces.

The agricultural interest lies in the eastern portions of the country; it is there where the intensive methods are used. The basis of the crop production is a close regulation of the water supply to the crop necessities. China has a network of canals which serve to drain land that has too much water, to irrigate land that has too little, and also as a means of transport and communication, the roads being bad. The rainfall is high; so far as the slender records go, it varies from 25 inches in the Shantung peninsula to 100 inches or more in the warmer sub-tropical parts; it is more variable in the north than in the south. Much of the lower land is drained, but almost always by open drains, occasionally in the south by bamboo pipes, but never, so the author tells us, by clay pipes. Drainage is, however, less important than might

appear, because the rainfall comes mainly in the summer, and swamp land is not the waste in China that it is in colder climates, for the paddy rice flourishes in it. The problem is rather the other way; land otherwise dry is watered so as to obtain maximum yields. This circumstance that the highest rainfall of the year comes in summer is an important factor in determining the intensiveness of Chinese agriculture. Crops have water during warm weather when they need it, and they are not hampered by high rainfall in winter when they do not need it. Where the winter is not too cold, two crops a year become possible; they are obtained on much of the land in the centre and south (though not usually in the north), especially on the tropical rice land which lies high enough to be dry in winter and yet can if necessary be flooded in summer. Even the low-lying wet land can be made to carry two crops.

The descriptions of the agricultural implements suggest affinities with Babylon and ancient Egypt rather than with Bronze Age north Europe, and it would be interesting to make a careful comparison between the agricultural system of ancient China and that of ancient Egypt so far as this is known or can be inferred from later Arabic writings. Some of the implements, however, notably the harrow and the roller, have a very western appearance.

Among the commonest manures are the mud from canal bottoms, green material cut from the large areas devoted to graves, and, above all, human excrements, all of which are carefully collected and applied to the land.

The chief food crops are rice and millet, and they form a good combination, since rice can tolerate any amount of water and millet does well in dry conditions, having great power of withstanding drought, and at the same time growing well when rain comes. The second crop, grown in winter, may be wheat, barley, beans, pease, or various vegetables. Land not well suited to rice, by reason of being too high above the water level of the canal, is devoted to bamboos, mulberries, fruit and vegetables.

This section of the book would have been more interesting had the author had more of his own photographs. As it is, he is driven to use illustrations from King's book of 1911. He devotes a great part of his book to descriptions of the crops, their varieties, and the conditions in which they are grown. The number of crops is amazing; including all the grain crops, many oil seeds, strange plants such as the lacquer tree (*Rhus vernicifera*)

and the tallow tree (*Sapium seliferum*), in addition to the better known tea, cotton—said to have been introduced into China from Khotan in the eleventh century—mulberry trees and other crops traditionally associated with the country. The animals are described at length, and finally the author collects some materials for a summary of the economic position of the Chinese farmer, an interesting attempt which one would like to see followed up.

As the only recent book on the subject, the volume would in any event be of interest to the agricultural expert. Added to this are its intrinsic merits; the mass of information, numerous illustrations by photographs and diagrams, and, where they can be obtained, figures of yields or analytical data. To those interested in eastern agriculture it will prove very valuable.

E. J. RUSSELL.

The Textile Industry.

Textile Bleaching, Dyeing, Printing and Finishing Machinery. By A. J. Hall. Pp. 320. (London: Ernest Benn, Ltd., 1926.) 50s. net.

THIS book is a very welcome addition to the literature of British textile industries. It brings together, in a complete form, a comprehensive summary of the best modern methods of carrying out the several important processes stated in the title of the book. Hitherto these processes have only received a cursory treatment and then simply as separate subjects. The author is to be congratulated on the able manner in which he has filled the gap in our technical literature and given an unusually complete survey of the mechanical methods used in carrying out the various processes.

The almost complete elimination of any idea of secret methods in spinning and weaving has been brought about by the publication of text-books, and the establishment of technical schools and research institutions. In the same manner progress can only be attained and maintained by clear statements of the best and most efficient methods of carrying out the processes of bleaching, dyeing, printing and finishing. The empirical methods of yesterday are totally inadequate to meet the world-wide competition of to-day, and they have always been a bar to development and progress. This book will place in the hands of the chemist, the engineer, the bleacher, dyer, and finisher a mass of information that will enable them to build up a solid business on sound constructive principles. Since each process is both important and extensive,

the book is necessarily large, and although it has been compiled under only nine chapters, the illustrations number 365, excellently reproduced in half-tone and line blocks.

The arrangement of the matter has not been by any means an easy task owing to the close interdependence of many of the processes, but the author has solved the difficulty in a fairly satisfactory manner. He deals with the machinery of various types used in each process, and whilst avoiding the display of preference for any particular machine, has the happy knack of so expressing himself that the reader can readily understand what machine will be best for any particular purpose. The book therefore becomes an invaluable work of reference, and is very suggestive, to a progressive man, in conveying ideas of further improvements.

Whilst machinery forms the staple matter in the book, each set of machines has an introductory explanation as to the necessity of the machines, so that the non-technical reader can readily understand the various steps carried out in any given process. A very wide field of textiles is covered, and whilst the chief aim is intended to be of real practical utility to the trade, the work may prove of great value and interest to many people who do not share in the actual production of textile materials, but are vital factors in dealing with the fabrics and materials after they are finished, including merchants, drapers, etc., and, even in many of our bleaching and dyeing works, the directors who have seriously to consider the question of equipment. All interested in this great industry will find the book of immense value, and we congratulate the author on what must have been a severe task. The book is well bound, its type is clear, and it bears evidence of the utmost care having been taken in its preparation.

W. S.-T.

Our Bookshelf.

How Natives Think (Les fonctions mentales dans les sociétés inférieures). By Prof. Lucien Lévy-Bruhl. Authorised translation by Lilian S. Clare. Pp. 392. (London: George Allen and Unwin, Ltd., 1926.) 12s. 6d. net.

In his preface to this book the author explains that "La Mentalité primitive," which appeared in English in 1923, and "Les Fonctions mentales dans les sociétés inférieures," of which this is a translation, are two volumes of one work. By an accident of circumstances, the second volume was translated into English before the first. This was unfortunate, as the essential principles of M. Lévy-

Bruhl's theories are contained in the latter, and although the two books can be read apart, some knowledge of these principles is necessary before the argument can be grasped as a whole.

M. Lévy-Bruhl's thesis is, in the main, a constructive criticism of the views of the English school of anthropologists at the head of which stand Tylor and Frazer. He holds that the work of this school is based upon an assumption that the working of the human mind is everywhere and in all cases identical. The vast body of facts relating to primitive peoples which have been gathered together in the employment of the comparative method, have been interpreted in the light of the animistic theory and explained by the law of association, whereas the author maintains they can only be understood as 'collective representations'—social phenomena having their own laws which no analysis of the individual *qua* individual, such as is implied in the method of the English school, can ever reveal. The 'difference in degree' in savage mentality which is recognised by the English school, therefore, becomes for M. Lévy-Bruhl a difference in kind.

Thanks in a great degree to the French school of sociologists and social anthropologists, and to the work of certain anthropologists in England, the tendency to consider facts entirely *in vacuo* is now by no means so marked as it has been. M. Lévy-Bruhl's stimulating book, in which the consequences of the difference of point of view are worked out in detail, is by no means so entirely destructive of English theory as he hopes, but it will serve as a caution and a corrective.

Light Treatment in Surgery. By Dr. O. Bernhard. Pp. xii + 317. (London: Edward Arnold and Co., 1926.) 21s. net.

In a foreword to this book, Prof. Leonard Hill refers to it as a masterly production, and we are inclined to agree with this verdict. The translator has done his work exceedingly well, and we now have a book to which we can turn with some confidence on the question of the use of light treatment in surgery; we hope that some one will be found who can cope with light treatment in medicine in as broad a comprehensive way as the author of the work under notice. We shall then be spared a continuance of the present holocaust of books written on the subject of ultra-violet therapy by writers of very little experience.

The book is divided into two parts, the first being general in its scope, the second, special in the sense that it deals with the actual light treatment in surgical cases. The two parts of the book are of about equal length, and the first five chapters give one a very good idea of our present state of knowledge on the effect of light on the organism generally, right up through the vegetable and animal kingdoms.

The second part of the book is divided into a section dealing with the indications for the use of this therapy and two sections on the helio-therapy of surgical tuberculosis. Scattered throughout the book are photographs and radiographs illustrating

the good effects which often accompany the treatment of patients with sunlight. That climatic conditions play an important part in the treatment of tuberculous patients is recognised by the author, and, in fact, twenty-five pages are devoted to this subject. In a book the object of which has been to set forth the beneficent action of sunlight in disease, a section of no less than twenty pages is devoted to the pathological action of sunlight. The dangers to specially sensitive subjects and those accompanying over-doses of radiation are dealt with very fully.

The book should be welcomed by those who have looked, so far in vain, for an authoritative account in English of this new, yet really very old, form of therapy. S. R.

An Outline of Plant Geography. By D. H. Campbell. Pp. x + 392 + 52 plates. (New York: The Macmillan Co., 1926.) 17s. net.

DR. D. H. CAMPBELL has written a simple and highly interesting outline of plant geography which can be read with pleasure and profit by the botanist, and also, which is of more importance, by all who are interested in the vegetation of the earth. He reviews in a light and pleasant manner the types of vegetation to be found in the north temperate zones of the old and new world, paying special attention to the interesting floral region of the western States of America and British Columbia. The south temperate zone is similarly discussed, and the central portion of the book is occupied with a description of the palæo- and neo-tropical regions, and their dense tropical forests. The descriptions of vegetation and scenery are enhanced throughout by numerous good and characteristic pictures, which add greatly to the interest of the book to the more general reader. Two prefatory chapters dealing with the succession of plants in geological times, the first land plants, man and the plant world, and the several climatic zones, give a useful summary of our knowledge of and the factors controlling the present distribution of plants.

It would have been useful for the more botanical reader had Dr. Campbell given the scientific names of some of the plants, to which he refers only by their popular names—names with which American botanists, no doubt, are quite familiar. It would also have been more convenient if data relating to rainfall, altitude, and temperature were given consistently either in the metric or English system. These, however, are only minor points in a very readable book, which is so readable because not only is it very well written, but also because the author writes with a personal knowledge of the vegetation of nearly every part of the world.

Civil Engineering Specifications and Quantities. By Dr. G. S. Coleman and G. M. Flood. Pp. xv + 282. (London: Longmans, Green and Co., Ltd., 1926.) 10s. 6d. net.

THE administration of contracts is one of the most arduous duties of the civil engineer, and this book should be of distinct value to those of limited

experience. An engineering contract may be divided into two parts, one legal and the other technical, and the book is roughly arranged to correspond. The legal sections, comprising ten chapters, are clearly written and illustrated by cases, but such legal expressions as "time is the essence of the contract, *prima facie*, *quantum meruit*," though commonplace to lawyers, are not always clearly understood by engineers, and a short explanation of them would enhance the value of the book. The technical chapters give suggested specification clauses for most of the general work carried out by civil engineers in excavation, embankment, concreting, masonry, brickwork, and steelwork.

The practice referred to is, as might be imagined, that common in the north of England, and in a few details would be modified in the south. The suggestion on p. 96 to paint reinforcing rods is rather unusual, and does not correspond with the advice given on p. 147. It would perhaps have been worthy of mention that wood street-paving blocks are laid with the grain vertical. The section on quantities is clear and straightforward. In essentials, building contracts and engineering contracts are similar, and a reference might have been made to the standard conditions of contract of the Royal Institute of British Architects, and to the standard method of measurement of building works of the Surveyors' Institution, which are often used as models for small engineering contracts.

E. E. MANN.

Types of Mind and Body. By E. Miller. (Psyche Miniatures, Medical Series, No. 4.) Pp. 132 + 5 plates. (London: Kegan Paul and Co., Ltd., 1926.) 2s. 6d. net.

THIS attractive little volume is an excellent introduction to the scientific study of the psychophysics of temperament and character. It deals in a critical and independent manner with the best recent work on types of physique and mentality, and also contains many interesting suggestions towards new lines of thought and investigation. Dr. Miller lays special stress, as is natural, on the work of Kretschmer, but he by no means neglects the work of the French and other schools. Perhaps the most important section is that which deals with the 'physiological background,' which gives, among other matters, a useful account of the functions of the internal secretions in relation to character and behaviour. Especially suggestive is Dr. Miller's discussion of the endocrine system as a link between metabolic processes and neural and mental processes, which throws light not only on the relation between mental and physical forms, but also on the more general problem of the relation between mind and body.

There are some interesting remarks about the relation between the types distinguished by recent workers and the racial types of the anthropologists, which need fuller justification. So far as is known, much the same types of temperament and character exist among all races of mankind, and this is scarcely compatible with anything like a simple corre-

spondence between the two kinds of types. In the psychological section there are some points which raise doubts, as, for example, the alleged relation between the ego-instincts and introversion, and between the sex-instincts and extroversion, but on the whole the treatment is both balanced and stimulating. There is a very well-chosen bibliography.

MORRIS GINSBERG.

Exercises in General Chemistry and Qualitative Analysis. By Prof. H. G. Deming and Prof. S. B. Arenson. Second edition, revised. Pp. xii + 282. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 9s. net.

THE authors of this manual express the "opinion that quantitative work in an elementary course often consumes time that were better spent in the accumulation of useful and necessary qualitative information." Quantitative work is therefore reduced to a bare minimum and a scheme for the qualitative investigation of chemical phenomena, covering a fairly wide field, has been elaborated. A novel feature is the introduction of linear scales showing the relationship between the temperature and the vapour-pressure of water and between the density and the concentration of several common reagents. Working directions are minutely specified, and almost every page is liberally sprinkled with cross-references, which are likely to bewilder the student, whose natural desire to discover things for himself is stifled by the warning in heavy type that *all unauthorised experiments are strictly forbidden*. Yet the authors hope to "foster something of the research spirit at an early age"! About one-fourth of the book deals with ordinary qualitative analysis, this section being prefaced with the following instruction to the beginner: "The work is based on differences in solubility. Commit to memory the table of solubilities and get some class-drill in its applications." Such methods will not appeal strongly to teachers in English schools.

A Junior Inorganic Chemistry. By R. H. Spear. Second edition. Pp. viii + 392. (London: J. and A. Churchill, 1926.) 6s. 6d. net.

THIS little book, which is designed for junior forms, appears to possess no strikingly original features. It is, however, lucidly written and it contains a fair number of illustrations, though some of them are rather crude. There appears to be no direct reference to Fig. 13 in the text, nor is it clear to the reader that the rather wide tube dipping into the beaker in all probability represents a thermometer. Again, the muffle-furnace, depicted on p. 59, needs some explanation in the text. Some of the headlines are badly worded or even startling. Thus on p. 27 a paragraph of about five lines is headed "To show that Matter is not Created by the Rusting of Iron." The investigation of the rusting of iron in a later chapter is fairly good, but it might have been carried a stage further by considering the action of air-free water upon the metal. The weight of a litre of air is given incorrectly on p. 24 as 0.001293 gm.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Atomic Weight of Silver.

IN reply to Prof. Brauner's criticism (NATURE, Mar. 5, p. 348, and April 9, p. 526) of our determination of the atomic weight of silver (*J.C.S.*, 1926, 128, 2510), we have now investigated the volatility of silver and have most emphatically confirmed our original statement that no silver could possibly have escaped from the silica tube during the final melting in hydrogen.

Some finely divided silver, prepared by heating the oxide in air to 350°-400° C., was introduced into the silica tube shown in the diagram (Fig. 1). The tube was heated in the electric furnace for an hour at 700°-800° C., for a similar period at 800°-900° C., and finally for five hours at a temperature of 1000° C., whilst a slow stream of hydrogen passed through the

FIG. 1.

tube and bubbled through the dilute nitric acid ($\text{HNO}_3 : 2\text{H}_2\text{O}$). The nitric acid was then poured into a nephelometer tube and a little dilute potassium bromide solution added. On examination of the nephelometer no turbidity could be detected, even after standing for several hours. On the addition of 0.2 c.c. of N/1000 silver nitrate (0.02 mgm. silver) an immediate and comparatively dense turbidity developed.

Taking into consideration the relative sizes and positions of the silica tube as used in the atomic weight determination (shown by dotted lines in Fig. 1), and the silica tube used in this experiment, also the time of heating, which was only twenty minutes in the determinations, then it is quite conclusive that no silver could possibly have escaped from the original silica tube.

On examination of the tube after the experiment, an extremely minute sublimate was observed 3 cm. from the silver bead, showing that the silver is slightly volatile, but not to anything like the extent suggested by Prof. Brauner.

Our preliminary investigations on the decomposition of silver oxide showed that it was essential to melt the silver in hydrogen after the initial decomposition. Silver, prepared from silver oxide by heating at 400° C., is a coherent mass full of voids. It could almost be called sintered. The loss in weight on melting in hydrogen was between 2 mgm. and 3 mgm.

In estimating the weight which ought to be attached to any determination of a constant such as an atomic

weight, we would suggest that it is only the experimental facts which deserve consideration. Our determination of the atomic weight of silver has an advantage over others, in that it is the only one in which the direct ratio of silver to oxygen has been measured.

H. B. BAKER.

H. L. RILEY.

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Radioactivity and the Heat of the Earth.

IN a previous letter to NATURE (vol. 119, p. 277, 1926) I have discussed Dr. J. W. Evans's suggestion that the existence of pleochroic haloes in mica indicates that much of the energy of the rays from the radio-elements in rocks is used up in producing physical, chemical, or atomic rather than thermal changes in the surrounding minerals. I concluded that the close agreement between the calculated and measured heat productions of the radio-elements affords strong evidence for the view that "practically the whole of the energy associated with the radiations emitted by these elements is available for raising the temperature of the rocks in which they occur." In a later communication (NATURE, vol. 119, p. 424, 1926), Dr. Evans infers that if measurements of the heat production of radium were carried out in a mica container instead of in a glass tube, the results of experiment and theory might not show such good agreement, in spite of the fact that the fluorescence effects and colorations produced by the radiations and the thermo-luminescence resulting from subsequent heating of the coloured materials are quite analogous for the two substances. From the viewpoint of geothermal problems, the importance of an unequivocal decision on the question at issue is perhaps sufficient justification for my returning to the subject, for several independent lines of thought support the conclusion arrived at in my previous letter.

Since it can be obtained in very thin uniform sheets, mica has always been used extensively in absorption experiments with α -rays; its behaviour is perfectly normal. The calculated range of α -particles in mica, as in glass and aluminium, is in good agreement with that found by experiment. This we should not expect if the behaviour of mica as regards absorption were abnormal. In such a case, either each α -particle would lose an appreciable amount of its energy in promoting, say, chemical change and the observed range in mica would be smaller, or the α -particles would lose different amounts of energy in this way, when the range would be indefinite, in opposition to observations of pleochroic haloes where the range is sharply defined. Furthermore, the proportion of the energy of α -rays utilised in promoting atomic changes in mica must also be very small, for mica has been used extensively in absorption experiments on atomic disruption, and the number of H-rays observed, particularly when the mica has been outgassed, is insignificant for present purposes.

Dr. Evans mentions that Dr. Alfred Brammell found it necessary to keep biotite at a dull-red heat for about six hours to render the pleochroic haloes invisible; but here I think he has misunderstood my previous reference to the thermo-luminescent effects with minerals coloured by radioactive radiations. When coloured glass or minerals are heated appreciably, but below dull-red heat, the thermo-luminescent effect is of relatively short duration, and may often be designated a flash. My statement that the energy liberated during the process is "manifestly small"

was based primarily on visual impression, but it is supported by the fact that if an appreciable proportion of the radioactive energy from an inclusion were stored in the pleochroic sphere and liberated on heating, the energy so released would correspond to a flash of intensity about 10^{10} times greater than that necessary to excite the retina of the eye. Moreover, Duane has shown that when radium is mixed with a material which fluoresces strongly under the action of the rays emitted, the measured heat production is identical with that obtained with radium alone,—a result which surely admits of no other interpretation than that the energy of luminescence is negligibly small.

Quartz, and to a less extent glass, when subjected for a long time to intense radiation from radium, develops tiny fractures or cracks which can be removed by continued heating above the softening point of the material, just as devitrified glass can be restored to condition by suitable heat treatment. I am inclined to attribute Dr. Brammell's observation to an analogous mechanical effect in the mica, the original crystal lattice being restored by the later heating at dull-red heat. Markings in the outer shell or in the body of the pleochroic sphere might also arise from the escape of gases on the application of heat. Thus for a representative sphere (radius of sphere = $30\ \mu$; radius of inclusion = $1\ \mu$; age = 500 million years) the volume of helium available in the outer shell, neglecting diffusion, would be about thirty times the volume of the inclusion, and the oxygen contained in the mica of one-thousandth part of the pleochroic sphere would occupy a volume equal to that of the sphere.

The evidence of heats of formation also renders it probable that most of the radioactive energy is converted into heat in the mica, for the calculated amount of heat available from radioactive sources during the life of the pleochroic sphere of the above-mentioned dimensions has about twice the value of the heat of formation of a volume of water equal to that of the sphere. The heat of formation of mica is unknown, but on the assumption of an additive law for the constituent parts, I find that the radioactive energy liberated within the pleochroic sphere is of the same order of magnitude as the estimated heat of formation of an equal volume of mica.

It is observed that for each gram of radium some thirty or more cubic centimetres of electrolytic gas are produced daily in an acidified aqueous solution of radium, the requisite energy being derived primarily from the α -particles emitted. Knowing the heat of formation of water and the daily heat development of radium, we can readily deduce that only about two per cent. of the energy of the radioactive rays is used up in promoting chemical change in the solvent. When an identical amount of radiation acts on ice, the resulting amount of chemical change is much less than in the case of water, and for a stable mineral like mica it seems reasonable to conclude that the amount of chemical change produced will be exceedingly small.

The concordance of evidence advanced in this and in my previous letter is very strongly opposed to the views expressed by Dr. Evans, and I shall only briefly refer to the latter part of his letter. He points out that the presence of extensive granite and gneiss in and below the deep boring at Dubbelde Vlei, in the Cape Province of South Africa, seems to have had no appreciable effect on the temperature gradients. In the absence of actual measurements of the radioactivity of these rocks, however, it would be futile to attempt to discuss the above observations of temperature gradient, though it seems not unlikely

that low radioactivity is the reason for the low gradients. The thickness of the granitic and basaltic layers, however, will also exert an influence. Prof. Holmes has referred to the gradient difficulty in two recent papers (*Geol. Mag.*, vol. 62, p. 533, 1925; vol. 63, p. 313, 1926) without coming to a decision as to the cause; but he is also convinced that anomalous absorption of the radioactive rays is insignificant in this connexion, and that practically the whole of the energy of the radiations from the radioactive substances in igneous rocks is available for raising or maintaining the temperature of those rocks.

It is to be hoped that before long additional evidence will be obtained on the question of the temperature gradients associated with, and the radioactivity of, the granitic layer in different parts of the world. Meanwhile it is interesting to recall that high gradients are associated with the highly radioactive granitic rocks of the Simplon tunnel, and that independently of the petrographic nature of the dominant rock type, some regions of the earth's surface are known to be characterised by more intense radioactivity (*e.g.* the Alps) than others (*e.g.* New Zealand). In future discussions it will be necessary to take account of the well-established radioactivity of potassium in this connexion, for in igneous rocks the thermal effect of potassium appears to be of the same relative importance as that of uranium or thorium.

ROBERT W. LAWSON.

University of Sheffield.

The Energy of Photo-electrons produced by Soft X-rays.

IN a series of experiments carried out in Prof. O. W. Richardson's laboratory at King's College, London, I have attempted to measure the velocity of the photo-electrons set free from a metal under the influence of soft X-rays, excited in the usual way by electrons from a hot filament falling on the radiator through an accelerating potential difference of 50-800 volts. The results obtained with the stopping-potential method—in which a varied retarding potential is applied to a surrounding electrode, thus preventing all electrons with a kinetic energy below the corresponding value to escape—are difficult to interpret because of the masking effect of scattered radiation on the measurements for higher voltages. Various forms of magnetic methods have also been tried, of which the last one has yielded definite results. In this apparatus the photo-electrons are emitted from a narrow rod forming the axis of a short cylindrical ring, connected to the electrometer and kept at the same potential as the rod. A variable magnetic field, applied in the direction of the axis, prevents electrons with velocity less than a certain value from reaching the cylinder.

In the measurements so far obtained, the potential on the tube was 700 volts. The anode-radiator was of carbon and the rod of copper—clean or covered with a thick coating of lamp-black. In both cases the curves show that the preponderance of low-speed electrons in the emission is very great indeed. More than 70 per cent. of all the electrons emitted have energies less than 10 volts. The following is a typical set of values showing the relative number of electrons within an equal interval in volts for different points on the distribution curve:

Energy (volts) .	2	5	8	20	50	100	150	200 volts.
No. of electrons .	100	41	14	2.5	1.6	0.7	0.5	0.3

It may be that this low average energy of the electrons results from the greater part of the incident

velocity of travel a single α -crystal will grow to a length of 20 cm. or more in wire 1 mm. in diameter.

Crystals have been grown in a vacuum and in an atmosphere of nitrogen, but the best results have been obtained in hydrogen at atmospheric pressure. The rate of travel principally used has been about 4 cm. an hour, but higher and lower rates have also given good results. The chemical purity and previous mechanical history of the iron seem relatively unimportant. Most of the experiments have been made on remelted electrolytic iron, but impurities usual in commercial iron do not inhibit growth. In a particular experiment, long crystals were grown in hard-drawn piano wire containing originally 0.8 per cent. carbon. In the final state the amount of carbon had been reduced, but, as judged by resistivity measurements, the carbon content was probably still greater than 0.3 per cent.

The large crystals occupy the whole cross-section of the wire, there being no surface layer of fine crystals as is usual in crystals grown by over-strain with subsequent annealing. Etching with nitric acid develops planes of the form {100}, so that an optical goniometer serves to locate the cubic axes normal to these reflecting surfaces. The orientations so found have been checked by X-rays, which permit more exact location than does the optical method. A considerable variety of orientations has been obtained, and it cannot yet be said whether there is any preferred orientation.

Irregularity in tension on the wire and torsional stresses in it result in twinning. Twins may either appear as small inclusions or as complete changes in orientation with the twinning plane traversing the entire cross-section of the wire. The twinning plane is of the form {211}.

The magnetic and magnetostrictive properties of long crystals free from twins are being investigated. These properties appear in some respects to differ from those of crystals prepared by others¹ by the method of over-strain and annealing. The initial permeability of nearly carbon-free crystals grown in hydrogen lies between 2000 and 2500, the maximum permeability is around 20,000, and the coercive force about 0.2 gauss. After treatment, which should remove hydrogen (its actual removal has not been proved) the initial permeability drops to a few hundred, the maximum permeability rises to nearly 40,000, and the coercive force diminishes slightly. A crystal grown from piano wire in hydrogen and not further treated had an initial permeability of about 1000, but was otherwise much like the purer crystals in magnetic behaviour, though stronger mechanically. The dependence of properties upon crystal orientation in the wire, and the behaviour in fields of more than 50 gauss, have not yet been determined.

Plastic deformation of the crystals, even to the slightest extent, causes considerable changes in their magnetic behaviour, and restoration of the original condition by annealing seems only to be possible when the amount of deformation has been minute.

The method is being extended to iron alloys possessing in the cold the body-centred structure characteristic of pure iron and having an allotropic change at nearly the same temperature.

L. W. MCKEEHAN.

Bell Telephone Laboratories,
New York, N.Y.,
Mar. 2.

¹ Webster, W. L., *NATURE*, 117, 859 (1926); *Proc. Roy. Soc.*, 107a, 496-509 (1926); 108a, 570-584 (1926); 113a, 196-207 (1926). Gerlach, W., *Phys. Zeit.*, 26, 914-915 (1925); *Zeit. f. Phys.*, 38, 828-840; 39, 327-331 (1926). Honda, K., Kaya, S., Masuyama, Y., *NATURE*, 117, 753-754 (1926). Honda, K., Kaya, S., *Sci. Rep. Tohoku Univ.*, 15, 721-753 (1926). Honda, K., Masuyama, Y., *Sci. Rep. Tohoku Univ.*, 15, 755-776 (1926).

The Transmutation of Hydrogen into Helium.

A FEW months ago, K. Peters and I published an account of experiments we had made in an attempt to transmute hydrogen into helium (*Ber. d. Deutschen Chem. Ges.*, 59, 2039; 1926). A more or less detailed account of this publication appeared in the columns of *NATURE* (vol. 118, p. 526, 1926), and perhaps I may be permitted to refer to a more recent publication on the same topic by K. Peters, P. Günther, and myself (*Ber. d. Deutschen Chem. Ges.*, 60, 808; 1927). In this communication, as a result of further experiments, we feel that we are in a position to give an explanation of the occurrence of the observed very small quantities of helium in our experiments, without having recourse to the assumption of a synthesis of helium.

In the first-mentioned communication we considered the penetration of helium from the atmosphere through the glass walls of the apparatus to be the most likely source of trouble in such experiments, and we excluded this possibility by the use of vacuum jackets, immersion in water, and similar devices. In addition, we also discussed the possibility of regarding the helium dissolved in the glass as an explanation of the observed effects, but blank experiments led us to the conclusion that the quantity of helium capable of being liberated in this way was beyond the limits of sensitivity of our method of detection. In the interval we have carried out experiments both in the Baker Laboratory of Cornell University and in the Chemical Laboratory of the University of Berlin, and these have shown that the liberation of helium from glass (and from asbestos) is dependent on the presence of hydrogen. Thus glass tubes which gave off no detectable quantities of helium when they were heated in a vacuum or in oxygen were found to yield helium in quantities of the order of 10^{-9} c.c. when they were heated in an atmosphere of hydrogen. Now in the earlier experiments the glass tubes containing palladium yielded helium, whereas the empty glass tubes used in control experiments did not; and since the former tubes would fill with hydrogen on the application of heat, we see that the source of the helium lay not in the palladium but in the glass, in spite of appearances to the contrary.

Our method of detecting helium is sufficiently sensitive to show that a glass tube which has been completely freed from its content of helium by heating in hydrogen takes up a detectable amount of neon-free helium from the atmosphere even after only one day's contact with the air.

Since asbestos behaves similarly to glass, we now see why one particular palladium preparation, bought as palladium-asbestos, yielded larger quantities (10^{-7} c.c.) of helium after being charged with hydrogen. Here, obviously, in contrast to the preparations we made ourselves, the asbestos had not been ignited until it was free from helium, and a fraction of the residual helium was always liberated by heating when the palladium was charged with hydrogen, whereas in oxygen no development of helium could be observed.

As a result of our more recent experiments we have thus established that, in using an apparatus made of glass, one cannot make any trustworthy statement as to the origin of 10^{-9} c.c. of helium if air comes in contact with the apparatus, parts of which are later heated in hydrogen. By avoiding all heating of the apparatus, we shall endeavour to decide whether a transmutation of hydrogen into helium of the order of 10^{-9} c.c. or less takes place. In any case, the amount of helium formed in experiments on electric discharges, as tested by various workers

and by ourselves, and in experiments on the action of palladium, does not reach the order of magnitude of 10^{-8} c.c.

It is scarcely necessary to emphasise the fact that the sensitiveness of our method, though limited to 10^{-8} c.c., is sufficient to decide with certainty the other questions dealt with in our first communication, such as the helium content of meteorites, the helium development of radioactive deposits, and so on.

Fritz Paneth.

Berlin, Mar. 2.

Measurement of Radiation Intensity by Photographic Methods.

IN a letter to NATURE of Jan. 16, 1926, p. 83, Dr. F. C. Toy criticised the use of calibration curves in photographic spectro-photometry; but the grounds for his objections were rather the difficulties in the way of adequate calibration than any quarrel with the main assumption involved, namely, the essential uniformity of the plates of a single batch. Recently, however, Miss C. H. Payne and Mr. F. S. Hogg have concluded that each of their plates requires separate calibration, a conclusion fully borne out by the sample curves given by them in Harvard Circular 301.

The work at this Observatory in connexion with Prof. Sampson's method of stellar spectro-photometry has been free from trouble due to the variations of individual plates: indeed, the curves for different batches of plates, on the similarity of which no reliance is placed, are far more consistent than those for individual plates at Harvard. Fig. 1 shows

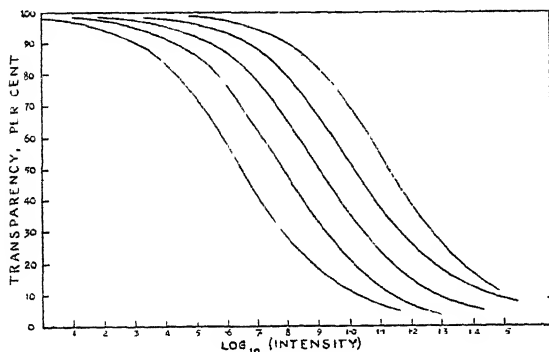


FIG. 1.

the calibration curves for wave-length 6100 Å.U. of the five batches of plates of the same make used during the last three years. It will be noticed that the differences are confined to the transparencies smaller than 20 per cent., that is to say, to the region which is strongly affected by the duration and temperature of development. A much closer agreement would have resulted had the first and fourth batches received somewhat longer development. The differences found at Harvard are of a totally different character, affecting the whole curve. In this respect they strongly resemble those found by Messrs. L. A. Jones and E. Huse (Eastman Kodak Research Laboratory Communication No. 193), which were eventually traced to different batches of chemicals used in making up the developer.

This suggests that these variations of individual plates may be due to the sensitiveness of the emulsion to slight changes in the composition of the developer, in which case a change of developing agent might lead to consistent results.

E. A. BAKER.

Royal Observatory, Edinburgh,
April 16.

Ionisation Potential of Hydrogen Fluoride.

THE ionisation potential of hydrogen fluoride has not yet been worked out experimentally. Several attempts have been made to calculate it on thermochemical data, on the assumption that hydrogen fluoride is ionised into H^+ and F^- . Such a calculated value, notably by Glocker (*Phil. Mag.*, 1924), appears to be 15.67 ± 0.7 volts.

Such a process of ionisation with molecular dissociation at the lowest ionisation voltage has been doubted by Mackay (*Phys. Rev.*, 1924), who has stated that even in the cases of those hydrogen halides where thermochemical data have yielded results in accord with experiment, the coincidence may be fortuitous. It has also been shown by Duffendack (*Phys. Rev.*, 1925) that "even with an intense arc in HCl vapour up to 70 volts, no trace of hydrogen spectrum could be obtained."

I have calculated the ionisation potential of fluorine. $E = 16.7$ volts (*Phys. Rev.*, awaiting publication). This calculated value seems to be justified by Prof. H. Dingle's recent observation of the ionisation potential of the neutral fluorine atom (approx. 17.0 volts) (*Proc. Roy. Soc. A.* 113, 323). Ionisation values of hydrogen chloride, bromide, and iodide are all found to be greater than the corresponding values of chlorine, bromine, and iodine; and hence one is led to believe that the ionisation potential of hydrogen fluoride may also be greater than 16.7 volts or that the thermochemically determined value is too low.

On the other hand, there is reason to believe that the ionisation products of hydrogen fluoride may be $(HF)^+ + e$. This is the same kind of ionisation as that of the neon atom into $(Ne)^+ + e$. Hydrogen fluoride and neon are known to have a similar structure and an exactly similar disposition of outer electrons. In the case of hydrogen fluoride, the nuclear distance between the atoms is known to be greater than the atomic radius of neon (Bragg and Bell, *NATURE*, Mar. 24, 1921, p. 107), and thus the ionisation potential of hydrogen fluoride may be expected to be nearly equal, though somewhat smaller than that of neon (21.5 volts).

On the present view of ionisation in hydrogen fluoride, it can be shown on the Bohr-Sommerfeld theory that

$$I_{HF} \cdot (r_{HF}^2) = I_H \cdot (r_H^2) \cdot n.k.$$

where I_H and r_H stand for ionisation potential and radius of the normal (1, 1) orbit of hydrogen respectively, and I_{HF} is the ionisation potential of hydrogen fluoride and r_{HF}^2 is the mean square radius of the outer n, k electron orbit of HF .

By this method of calculation $I_{HF} = 18.04$ volts, $I_{HCl} = 13.8$ volts.

S. C. BISWAS.

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D.A.V. College, Lahore,
Mar. 31.

The Nuptial Pad of Kammerer's Water-bred Alytes.

I WAS delighted to read in NATURE of April 30, p. 635, a letter from Dr. Przibram vindicating the validity of Kammerer's results.

May I direct attention to one feature in the much-discussed Alytes which renders the assumption of fraud absurd?

This specimen when I saw it in 1923 showed a nuptial pad only on one side. Who, if he had wished to 'fake' an Alytes so as to deceive the public, would treat one palm only with Indian ink?

E. W. MACBRIDE.

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The Fields of Force in the Atmosphere of the Sun.

By Dr. GEORGE E. HALE, For. Mem. R.S.

THE structure of the solar atmosphere above and surrounding sunspots has been illustrated in a previous article in *NATURE*.¹ Single spots often lie at the centre of an apparent vortex resembling a terrestrial tornado or cyclone, sometimes nearly radial in form, more commonly showing marked clockwise or counter-clockwise curvature. Bipolar spots (Fig. 1) are often surrounded by a field of force similar to that of a bar magnet, though in many cases the structure is very different. I have recently discussed the nature of these fields of force,² but the evidence, which favoured a hydrodynamical rather than an electro-

surpassed by the spectroheliograph. For example, during the last few months the spectroheliograph has permitted me to observe repeatedly the rapid flow of large hydrogen flocculi toward sunspots, a phenomenon clearly recorded on a large scale but once in many years of work with the spectroheliograph. Moreover, it has also enabled me to measure the radial velocity of this inflowing gas, yielding results much higher than the Evershed effect would lead one to expect, but in good general agreement with the velocity of inflow of prominences photographed in elevation at the sun's limb by Slocum and Pettit with the Rumford spectroheliograph. It has also enabled me for the first time to distinguish quickly and clearly between these inflowing streams and the outflowing jets which often result in arched prominences. By rendering possible a study of these arches, seen in projection against the disc, it has shown that the 'bar magnet structure' surrounding bipolar spots is not necessarily an electromagnetic effect.

THE ELECTROMAGNETIC THEORY.

In 1912, at my request, Prof. Carl Störmer visited the Mount Wilson Observatory to investigate the theory of the fields of force shown by the hydrogen flocculi. I quote from his paper entitled "Researches on Solar Vortices"³:

"The detailed study of the collection of spectroheliograms made at the Observatory suggested to me an application of the classical researches on terrestrial cyclones made in 1876 by my countrymen Guldberg and Mohn. The hydrogen flocculi seemed to be arranged around a single spot in curved paths that were very similar to logarithmic spirals; and just the same curves were found by Guldberg and Mohn as trajectories of the air particles in the outer part of cyclones. It therefore seemed advisable to start with the hypothesis that the motion of charged electric gas molecules takes place along such spirals around the sunspot centre, and compute the resulting magnetic field.

"This investigation which I made in Pasadena showed that the lines of magnetic force due to a plane whirl of the kind mentioned above are space-curves whose projections on the plane of the whirl are also logarithmic spirals intersecting the first at right angles.

"This result led me to the idea first advanced by Brester in 1909, that the hydrogen flocculi resemble terrestrial auroras, thus implying that the visible whirls are not real current-lines, but lines of magnetic force due to a magnetic field at a lower level—a view expressed by Deslandres in 1910. Professor Hale had previously stated in his papers that the Zeeman effect

³ *Contributions from the Mount Wilson Observatory*, No. 109; *Astrophysical Journal*, 43, 347; 1916.

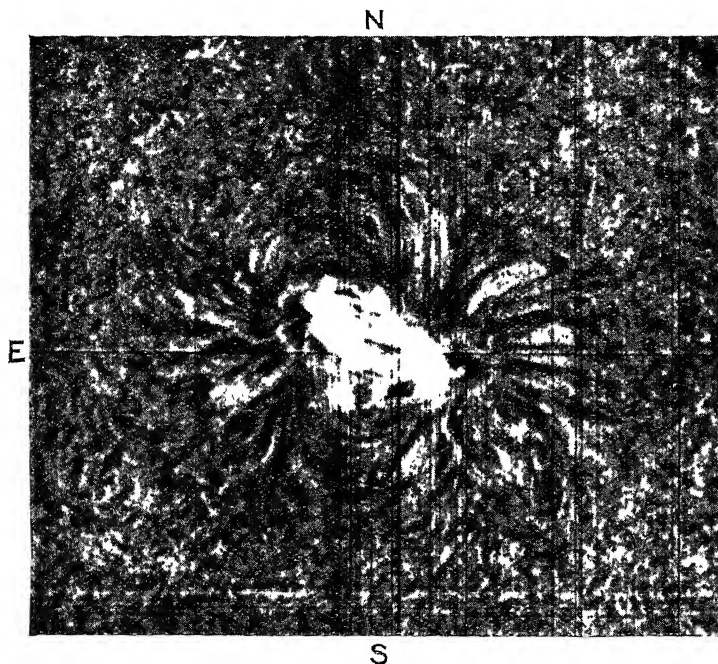


FIG. 1.—Field of force in the hydrogen atmosphere surrounding the bipolar spot of Aug. 20, 1924. The structure of the hydrogen flocculi resembles the field of force surrounding opposite magnetic poles.

magnetic explanation, was inconclusive, especially in view of the prevalence of the bar magnet type so frequently associated with bipolar spots. This seemed to point to an electromagnetic origin, and the impossibility of analysing adequately the structure of the hydrogen flocculi in these bipolar fields has greatly impeded progress.

In the study of this problem the spectroheliograph, described in its preliminary form in my earlier article in this journal,¹ has proved to be indispensable. The spectroheliograph remains our best means of photographing the fields of force in the solar atmosphere; but as a device for detecting certain hitherto unrecognised phenomena, and of interpreting many puzzling questions, it is greatly

¹ "Some New Possibilities in Solar Research," *NATURE*, July 3, 1926, Supp. p. 1.

² "A Test of the Electromagnetic Theory of the Hydrogen Vortices surrounding Sunspots," *Communications from the Mount Wilson Observatory*, No. 95; *Proc. National Academy of Sciences*, 11, 691; 1925.

was probably due to a low-level vortex. In accordance with the mathematical result mentioned above, the current-lines of this hypothetical whirl at a low level would be logarithmic spirals tending more and more to become circles according as the structure of the hydrogen whirl tended to be radial. This would much better explain the strength of the Zeeman effect of sunspots of radial structure."

Störmer's theory was developed merely as a working hypothesis and not as an expression of his opinion regarding the nature of these phenomena. According to the theory, the direction of the apparent whirl shown by the hydrogen flocculi (curvature of the projected lines of force), clockwise or counter-clockwise, should depend upon the sign, motion, and direction of the invisible low-level electric current surrounding the spot. As I have shown elsewhere,² a considerable modification of Störmer's theory, which was tentative in character and unavoidably based upon inadequate observational data, would be necessary in order to adapt it to the conditions as now known. If such modification be possible, the direction of curvature of the lines of force (and hence of the hydrogen flocculi supposed to follow them), clockwise or counter-clockwise, must conform with the magnetic polarity of the spots in question, if two reasonable assumptions are permissible. These assumptions are that the sign of the charge of the particles producing the field, as well as the direction of any radial component of motion, inward or outward, are invariable in all single spots and in the preceding spots of bipolar groups. While the evidence is insufficient, there seems to be no reason to doubt the validity of these assumptions. We may thus have a simple criterion which should enable us to determine whether the apparent vortices in the solar atmosphere surrounding single spots represent the lines of force of their magnetic fields. If so, the direction of curvature, clockwise or counter-clockwise, should be determined by the polarity of the field in question.

In the paper just cited, I have given the results of a preliminary test, based upon an examination of 51 hydrogen whirls photographed at Mount Wilson on various dates scattered over the period

1908-1924. Summarising the polarities and directions of whirl without regard to date, spot-type, hemisphere, or latitude, we find:

No. of spots.	Polarity	Direction of whirl
9	N	Clockwise.
16	N	Counter-clockwise.
13	S	Clockwise.
13	S	Counter-clockwise.

These results thus offer no support to the electromagnetic hypothesis. The same results, however, when grouped for the northern and southern

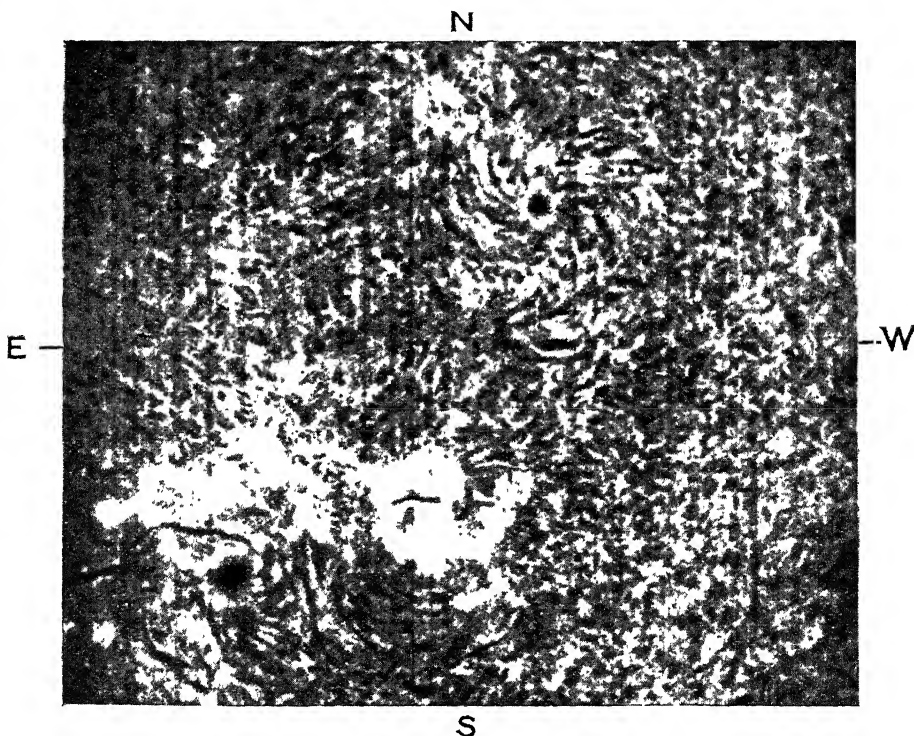


FIG. 2.—Hydrogen whirls surrounding single spots in the northern and southern hemispheres, July 21, 1919.

The directions of whirl in the northern and southern hemispheres are counter-clockwise and clockwise respectively. The northern spot is of north polarity and the southern spot is of south polarity.

hemispheres, show that 81 per cent. of the northern whirls are counter-clockwise and 84 per cent. of the southern whirls are clockwise, irrespective of the magnetic polarity of the accompanying spot, thus agreeing in direction with terrestrial cyclones.

I have since made a more critical examination of this question, excluding members of bipolar spots and other cases of low weight included in the above summary, and adding a number of other cases of high weight. Limiting the results to single spots, which are usually more trustworthy than the preceding members of bipolar groups, we have:

No. of spots.	Polarity.	Direction of whirl.
11	N	Clockwise.
14	N	Counter-clockwise.
12	S	Clockwise.
6	S	Counter-clockwise.

These results seem to prove beyond doubt that the direction of whirl at the level of the hydrogen flocculi is not determined by the magnetic polarity of the underlying spots. Apparently, however, it is determined by the hemisphere, as 83 per cent. of all these whirls are counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The significance of this correspond-

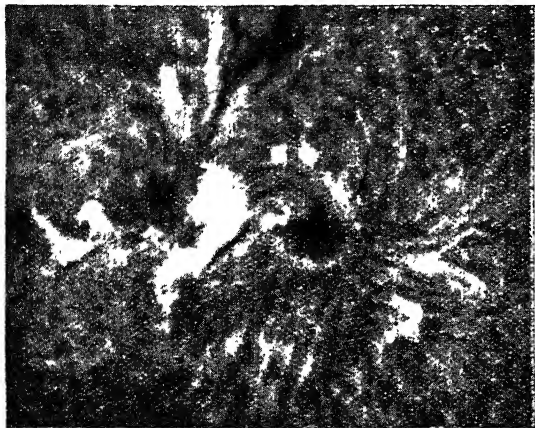


FIG. 3.—Spectroheliogram showing hydrogen whirls surrounding the spots of the southern bipolar group of Aug 15, 1926. Both are clockwise and both showed inflow, as illustrated for the preceding spot in Fig. 4.

ence with the terrestrial law of cyclonic storms seems to be greatly enhanced by the fact that hydrogen whirls, which are distributed over two successive $11\frac{1}{2}$ year cycles, show no indications of reversal in direction following the sunspot minimum, corresponding to the reversal of the magnetic polarity of the spots that occurs in each hemisphere at this epoch (Figs. 2 and 7).

TESTS WITH THE SPECTROHELIOSCOPE.

Mount Wilson spectroheliograms taken during the present spot cycle, so far as I have examined them, are in harmony with the above results. Before reaching a final conclusion, however, it seemed advisable to make an independent test of the whole question with the spectrohelioscope, especially in view of the apparently serious difficulty presented by the fields of force of the bar-magnet type which so often characterise bipolar spots.

On account of my inability to make daily observations, and the necessity of devoting much of my attention to the various new phenomena revealed by the spectrohelioscope, the number of whirls included in this visual test is not large. Counting all cases, we find 14 (78 per cent.) in harmony with the terrestrial law and 4 opposed. All of the exceptions were associated with members of bipolar spots. Retaining only the single spots and the members of bipolar spots of highest weight, there remain 6 whirls (75 per cent.) agreeing in direction with terrestrial cyclones and 2 of the opposite sign.

In making these tests the spectrohelioscope offers some great advantages. On spectroheliograms the direction of whirl is generally inferred from the

form of the hydrogen flocculi, on the assumption that the flow is spirally inward. As a rule, a series of photographs taken in quick succession does not help materially, because the critical moments at which large flocculi are drawn into the whirl are infrequent, and thus are usually missed if visual observations cannot be made for guidance. At long intervals, however, a series of photographs thus taken blindly may chance to record a great inflow of hydrogen, like that illustrated in my first article on "Solar Vortices" in 1908.⁴ No case at all comparable with this in scale occurs among our thousands of photographs taken since that time. Similarly, we have few satisfactory records showing definite outflow. In examining a single photograph, or a series of photographs taken under customary conditions, we may therefore be left in doubt whether the flocculi really indicate inflow or outflow.

With the spectrohelioscope, however, there is much less room for doubt. In the course of my visual observations with this instrument I have repeatedly seen intensely black hydrogen flocculi, sometimes of great size, suddenly develop near active spots. When first formed, these are usually found to be rising at high velocity from regions marked by bright hydrogen flocculi, and if near the centre of the sun they may completely escape detection by the spectroheliograph unless they give an $H\alpha$ line sufficiently wide to overlap the second slit (supposed to be set at the centre of the undisplaced line). They are easily picked up with the spectrohelioscope by the aid of the line-shifter—a plane parallel glass plate in front of the oscillating second slit, which can be rotated so as to displace the $H\alpha$ line toward red or violet while observations are in progress. The divided circle on which this glass plate is mounted affords a quick and easy

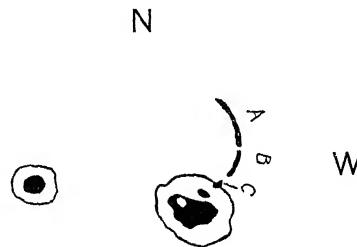


FIG. 4.—A new effect of inflow. Rapid acceleration in the radial velocity of the inflowing hydrogen is shown by the change in appearance of the flocculus from A through B to C when observed with light of increasing wave-length.

means of measuring the radial velocity of any portion of a hydrogen flocculus. At the beginning of a set of observations the second slit is adjusted so as to coincide with the centre of $H\alpha$ when the glass plate is parallel to the plane of the slit and thus produces no displacement. This gives the zero of the circle. To measure the radial velocity

⁴ Contributions from the Mount Wilson Observatory, No. 26; *Astrophysical Journal*, 28, 100; 1908.

the glass plate is turned so as to move $H\alpha$ toward the red, and several readings of the circle are made at the point where a bright or dark flocculus just begins to become visible against the background due to the continuous spectrum. This gives the wave-length (after calibration of the circle) of the violet edge of the bright or dark $H\alpha$ line in this part of the flocculus. A similar series of settings on the other side of the zero gives the wave-length of the red edge of the line, and half their sum (if the intensity curve is symmetrical) gives the centre of the displaced line, which may differ by an Ångström or more from the centre of $H\alpha$. A quicker but somewhat less accurate method is to take several readings of the circle corresponding to the position of estimated maximum intensity of the flocculus (centre of the displaced line).

In exploring the hydrogen atmosphere around a sunspot the observer keeps this line-shifter in constant use, turning well to the red and violet in order to detect rapidly moving objects. When such are found, he may observe and record the quick changes in form and radial velocity which make these observations so fascinating. Evidently we have in this simple device a certain means of determining not only the direction of whirl but also the varying radial velocity of a flocculus as it is swept toward a spot.

A NEW EFFECT OF INFLOW.

The spectrohelioscope thus offers two distinct methods of distinguishing between inflow and outflow: (1) By watching the approach of a flocculus toward a spot, as in the photographic record of 1908 just cited; and (2), when no such phenomenon is in progress, by utilising a beautiful effect first clearly recognised on Aug. 15, 1926—the progressive advance toward a spot of the maximum of intensity of a curved flocculus when the wave-length of the light entering the second slit is increased by rotating the line-shifter.

The spot in question was the preceding member of a bipolar group (Mt. Wilson, No. 2656) at 18° south latitude, then about 4° east of the central meridian. This spot was of north magnetic polarity, strength of field 2800 gauss; the following spot was of south polarity, with a field-strength of 2500 gauss. The beautiful details of the $H\alpha$ field of force surrounding the group (Fig. 3) were clearly seen, and one of them, the curved flocculus shown in the sketch (Fig. 4), which was more intense than the others in the same region, was selected for observation. When the circle of the line-shifter indicated a radial velocity of +22 km. per second, only the outer part of the flocculus (A in Fig. 4) was visible. As the line was displaced farther to the violet, the flocculus seemed to move from A to B, the portion B corresponding to a velocity of +45 km. per second. When the second slit was about 1.1 Ångströms to the red of the centre of $H\alpha$, corresponding to a velocity of about +50 km. per second, nothing remained visible of the flocculus except the black dot C on the edge of the penumbra. At still greater displacements the dot faded away and finally disappeared. The apparent advance of the

flocculus toward the spot and the disappearance of all but the head were observed as often as the $H\alpha$ line was moved across the second slit from violet toward red.

It is interesting to note the accelerating radial velocities indicated by the successive slit positions, increasing from 22 km. per second at a distance of 56,000 km. from the centre of the spot (A) to 45 km. per second at a distance of 36,000 km. (B) to about 50 km. per second for a distance of 20,000 km., corresponding to the dot marking

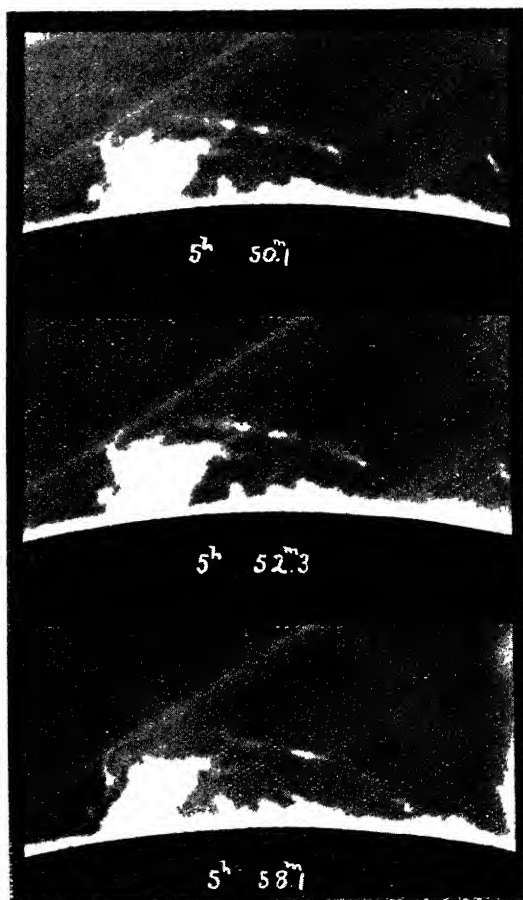


FIG. 5.—Slocum's photographs of the prominence of Oct. 22, 1910, showing inflow toward the spot at accelerating velocities.

the inner extremity of the flocculus on the outer edge of the penumbra (C). These values are not of the highest precision, but they cannot be far from the truth.

We at once recall the flow of prominences into sunspots,⁵ as photographed in elevation at the sun's limb by Slocum with the Rumford spectroheliograph (Fig. 5). Another series of calcium spectroheliograms of the prominences surrounding a large spot at the sun's limb on Oct. 8, 1910, is also

⁵ It should be clearly understood, however, that Fig. 5 represents three successive stages in the inflow of the tip of a prominence, whereas in the case illustrated in Fig. 4 the tip had already reached a point above the edge of the penumbra before the observations were begun. With a rather wide second slit, nearly the whole length of this curved flocculus (A to C) could be recorded in a single photograph, as shown in Fig. 3.

reproduced in his article on "The Attraction of Sunspots for Prominences."⁶ Slocum directs attention to three bright knots on a long streamer, which gave velocities along the apparent trajectory of 16 km., 20 km., and 60 km. per second, at distances of 170,000 km., 130,000 km., and 75,000 km. from the centre of attraction. Pettit, who re-measured these plates, got velocities of 5 km., 8 km., and 44 km. per second respectively. From these and other measures Pettit concludes: "Normally the matter about the spot is moving into it with accelerated velocities averaging about 35 km. per second, sometimes reaching 100 km. per second." Both Slocum and Pettit found that jets may be projected away from a spot at similar

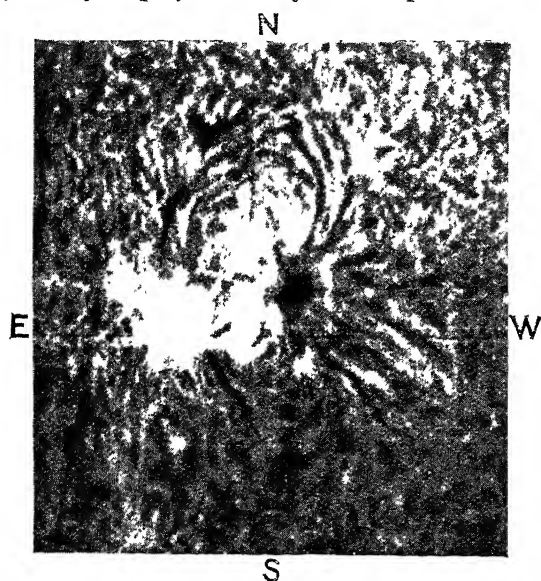


FIG. 6.—Single northern spot of July 9, 1919, connected with following eruptive centre by hydrogen flocculi resembling field of force shown by magnetic poles of opposite polarity. (Compare also Fig. 1.)

velocities, but Pettit⁷ does not consider them to represent the normal condition. Evershed, on the contrary, in discussing his Kodaikanal observations of prominences, says: "No case has been found in which prominences were falling into sunspots, but the reverse has several times been observed."⁸ The difficulties involved are sufficiently indicated by these differences in opinion among experienced observers, but fortunately most of these are removed by the spectrohelioscope, in so far as the determination of the direction of flow and the radial velocity are concerned.

It is evident, however, that the observed radial velocity must depend upon the velocity along the true trajectory and the angle between this trajectory and the line of sight. If the trajectory is parallel to the solar surface, and the spot, as in the present case, is near the centre of the sun, there will be no displacement of $H\alpha$, and the entire flocculus will be visible when the second slit of the spectrohelioscope is set on the centre of the line.

Judging from the characteristic forms of prominences at the sun's limb, this is usually the condition of affairs at a considerable distance from a spot, though it often happens that at such a point the hydrogen is rising rapidly from below, thus producing a marked displacement of $H\alpha$ toward the violet when observed near the centre of the sun. Nearer the spot, as the prominences at the limb discussed by Slocum and Pettit indicate, the trajectory makes an angle with the sun's surface ranging from small values up to 45° or even more. At the limb, the projection of the trajectory is usually nearly a straight line over a great part of its length, and the increase in the radial component of the velocity observed on the disc as the spot is approached is doubtless due chiefly to the acceleration found by Slocum and Pettit. Sometimes, however, their limb photographs show that the tip of the inflowing prominence turns down close to the spot, and in spectrohelioscope observations made near the centre of the disc, this might account in such cases for an increase in the radial component of the velocity at this point, without a corresponding increase in the acceleration along the trajectory.

The curved flocculus shown in Fig. 4 probably represents a prominence of moderate height. If we assume the trajectory to make an angle of 30° with the sun's surface, the corresponding velocities along the trajectory would be 44 km. per second for the outer part of the flocculus (A), 90 km. for the central part (B), and about 100 km. for the tip (C).

The observation of Aug. 15 proved to be typical, and it has been repeated in scores of cases, many of which will be described in detail in the *Astrophysical Journal*, where the bearing of these results on the work of St. John, Evershed, Fényi, Slocum, Pettit, and others will be discussed. In the present article I wish merely to point out this method of observation, in which the visibility of an object emitting approximately monochromatic light depends upon its radial velocity. The method evidently affords a valuable means of analysis, not merely of the hydrogen whirls but also of other important phenomena of the solar atmosphere. Among these are the fields of force of the bar-magnet type so often found in association with bipolar sunspots.

FIELDS OF FORCE SURROUNDING BIPOLAR SPOTS.

In the typical bipolar group the component spots, single or multiple, which form the preceding and following members are of opposite magnetic polarity.⁹ If the group consists of two nearly equal spots, of opposite polarity, the magnetic field of force surrounding the group should resemble the field surrounding two opposite magnetic poles. The question before us is whether the observed structure of the hydrogen flocculi, at a considerable height above the sunspot level, actually represents such an electromagnetic field as Störmer's theory would indicate.

⁹ See Hale and Nicholson, "The Law of Sunspot Polarity," *Contributions from the Mount Wilson Observatory*, No. 300; *Astrophysical Journal*, 62, 270; 1925.

⁶ *Astrophysical Journal*, 36, 265; 1912.
⁷ "The Forms and Motions of the Solar Prominences," *Pub. Yerkes Observatory*, 3, part 4; 1925.

⁸ *Memoirs Kodaikanal Observatory*, 1, part 2; 106.

We have seen that the evidence offered by the fields of force associated with single (unipolar) spots does not support the theory, and a glance at the bipolar group of Aug. 15, 1926 (Fig. 3), shows a similar lack of agreement. The hydrogen whirls surrounding the preceding and following spots were examined visually by the method just described, and a definite inflow was repeatedly seen. This agreed with the spectroheliograms in showing the direction of whirl to be clockwise about both spots, in spite of their opposite polarity. Moreover, on Aug. 16 a long, slender, dark flocculus, which had apparently risen from a bright flocculus south of the group, was found to indicate inflow toward the eastern extremity of the preceding spot along a trajectory lying nearly at right angles to the lines of force. Many similar cases in apparent contradiction with the theory might be cited.

On the other hand, structure like that shown in Fig. 1 is so common that it may almost be called typical. In such cases the $H\alpha$ flocculi surrounding a bipolar group strongly suggest the lines of force about two opposite magnetic poles. What evidence bearing on the nature of this structure is afforded by the spectrohelioscope?

On May 31, 1926, while observing spot No. 2571 (8° S., 20° E.) with the spectrohelioscope, I noticed a curious dark arch following the spot. The preceding end of this arch, which was seen when the second slit was on the violet side of $H\alpha$, seemed to rise from a small bright flocculus a short distance east of the spot. The central part of the arch, farther to the east, appeared when the slit was near the centre of $H\alpha$, but its eastern extremity, where it seemed to curve back toward the surface of the sun, did not become visible until the slit was well beyond the boundary of $H\alpha$ toward the red. Obviously we have here a dark arched prominence, rising with high velocity from a bright source near the sunspot, pursuing a curved trajectory, the central part of which was nearly normal to the line of sight, and falling with high velocity at a point well to the east of its origin.

Since that date I have observed many of these arches. In a bipolar spot group three or four may often be seen at once, rising from a region of bright flocculi and falling at a distance, sometimes on the penumbra of one of the spots, sometimes elsewhere. When the velocities are high and the oscillating slits narrow, only a short section of an arch may be visible at a given position of the second slit on $H\alpha$. To show the whole arch, the line-shifter must be employed. As the line moves across the slit from violet to red, the maximum of intensity may be seen rising from the source of the ascending branch, passing along the trajectory, and running down the descending branch, which often seems to terminate in a rather definite dark head. The effect is of course different in different parts of the sun, because it depends upon the angle between the true trajectory and the line of sight. In general, it is best observed in the central part of the disc, but I have frequently used the method with good success near the limb.

These applications of the spectrohelioscope will

serve to illustrate its advantages over the spectroheliograph when rapidly moving objects are under examination. Although I long ago recognised certain arches among the $H\alpha$ flocculi on spectroheliograms, and made a study of them by stereoscopic and other means in 1925, I could only suppose, but not prove, that the bar magnet structure might be due in part to them. In this study I made use of a series of spectroheliograms taken with the second slit set on the red and violet sides of $H\alpha$, and inferred that their differences might be caused by motion of the gas along the arch. More can be learned in a few minutes, however, from such visual observations as I have just cited than from the comparison of many spectroheliograms, unless these are made with the spectrohelioscope as a guide.

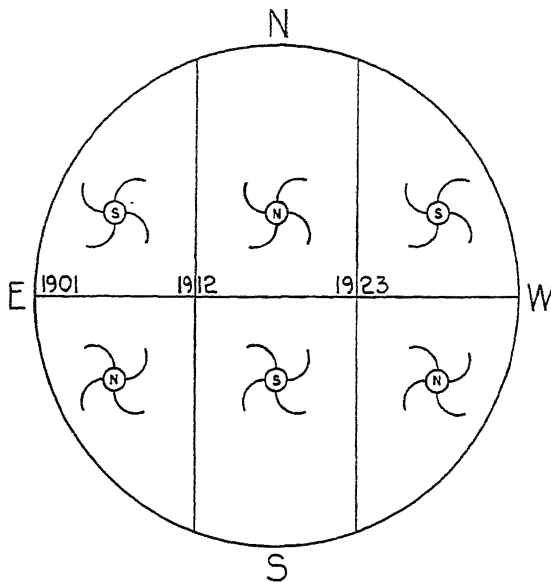


FIG. 7.—Law of single gyrating storms at two levels in the sun. About 80 per cent. of the high-level hydrogen whirls, in all sunspot cycles, are counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The underlying sunspot vortices, as inferred from the polarities of their magnetic fields, indicate opposite directions of whirl in the northern and southern hemispheres, and periodic reversal in direction of whirl at successive sunspot minima.

My spectrohelioscope and spectroheliograph are now being arranged for simultaneous use, so that I hope soon to have photographic records of the various types of phenomena described in this paper.

If groups of arched prominences originating in eruptive centres near the spots of a bipolar group are competent to account for the structure resembling the lines of force of a bar magnet, we might expect to encounter occasional indications of this structure between spots of the same polarity and also near single spots, *i.e.* where only one of the magnetic poles is present. I have found cases of both kinds on our spectroheliograms, one of which is illustrated in Fig. 6. The new evidence therefore seems to be strongly against the electromagnetic explanation, because of the phenomena exhibited by the inflowing gas and the apparent failure of the flocculi to coincide with the lines of force surrounding single spots, between pairs of spots of the same polarity, or between the members

of bipolar groups, where they often diverge, not from the magnetic poles (*i.e.* the spots themselves) but from bright eruptive centres at some distance from them. Nevertheless, as I shall show later, there still exist several difficulties in the way of accepting a purely hydrodynamical explanation of the structure accompanying single and double spots, and I am therefore reserving judgment until further studies can be made.

Whatever the results of these studies may be, I have already shown that many single spots are surrounded by hydrogen whirls, about 80 per cent. of which correspond in direction with terrestrial cyclones. We may therefore formulate an empirical law defining the direction of whirl of single gyrating solar storms (Fig. 7). For the high-level whirls shown by the hydrogen flocculi, this corresponds

in all sunspot cycles to the terrestrial law, counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. For the underlying vortices which constitute sunspots the actual direction of whirl is not known, but we may safely infer from the resultant magnetic polarity of the spots that it is opposite in the northern and southern hemispheres and that it reverses at each sunspot minimum. In Fig. 7 the whirls represent the hydrogen flocculi and the letters N and S the magnetic polarities of the underlying spots in three successive cycles. A general law probably cannot be formulated for the hydrogen whirls above bipolar spots, but for the bipolar spots themselves the law has been given in a previous article.¹⁰

¹⁰ "Sunspots as Magnets and the Periodic Reversal of their Polarity," NATURE, Jan. 19, 1924.

The Exhibition of the Royal Academy, 1927.

PASSING through the eleven galleries, in which 738 selected oil paintings of the year are displayed, the attention of any student of Nature is due perhaps to landscapes and other out-of-door pictures in preference to portraits, genre, or still-life, and with the critical habit that clothes the orthodox scepticism of the scientific mind, his first instinct is to point out how his colleagues of the brush and palette have failed to appreciate the shapes and colours of natural objects of their common care. It is, however, permissible to reverse the order, and taking the representations as real (wherever possible), to gather what the artists have to tell us about Nature that ought to come within the thought of our philosophy. In this year's Academy there is a fine picture of crepuscular rays with layers of cloud, "The Coming and the Going" (319), by C. Conway Plumbe, quite a good subject for a meteorological lecture.

Prominent in any exhibition of paintings are the colour of the sky and its gradation from a real blue up above, almost the cerulean blue of the poets, through a paler and still paler blue or green to a filmy, hazy white, or even dull grey, along the horizon, with or perhaps without any definite cloud in the visible sky. There are generally plenty of examples in any exhibition, and this one is no exception. In "Looking on to Antibes from Cagne, France" (162), Sir H. Hughes-Stanton gives a very good example: the same artist's picture of "Cagnes, Alpes Maritime, France" (241), is also typical, and in "Blackberries" (396), Harold Harvey has the gradation even too well marked. "The River Mill" (14), by Arnesby Brown, is also good. With less definite colour, "Shadow and Shine, Lake-end, Ullswater" (268), and "Loch Morar" (140), Sir David Murray, show beautiful gradation, and "November" (274), Hughes, is good enough. If we can believe what the artists tell us, there are days and places where the nebulous whiteness covers the whole sky and the gradation is of cloudiness, from the whitening of the blue above to the leaden skies which are characteristic of the British Isles. We can find examples of that kind of nebulosity in "Grey

Morning" (35), by Arthur E. Law, and "Sand Dunes on the Kentish Coast" (36), by Oliver Hall. W. L. Wyllie has the same touch in his picture "Waterloo: The Doomed Bridge" (128) and his "A Suggestion for the New Charing Cross Bridge" (139). W. W. Russell, in "Rochester: Evening" (53), also gives us an example of pervading and graduated greyness.

Artists, indeed, clearly differentiate themselves by their appreciation of detail and of colour; some see the blue and its gradation, and some apparently are more apt to see the greyness, or only paint a landscape when it is suffused with grey. The difference of habit is perhaps not all temperament. The photographic eye, which in these days ranges beyond the visible on either side, shows the same kind of discrimination. A photograph in the light of the extreme red is conspicuous for its clear definition, whereas the same landscape in ultra-violet light is hazy. An exhibition of paintings moves us to wonder whether different eyes are in some way sensitive beyond the visible range and whether some artists specialise in the infra-red, while others range themselves with the ultra-violet.

This carries us from the landscapes to the portraits, for in them we find an echo of the same kind of difference. Some portraits are meticulously detailed and not infrequently also ruddy, while others are suffused with a sort of mistiness and have a paler cast. The portraits by Orpen are conspicuous for their definition and their colour. In (723) Prof. J. A. Fleming forces a hard smile while floating in a sea of scarlet and yellow. Lavery, in like manner, has marked definition and bold colour; but Solomon J. Solomon paints The Right Rev. the Lord Bishop of Worcester (44) in the more hazy part of the spectrum and with less violent definition.

Talking about culture and civilisation, philosophers have classed art, music, literature, and the mathematics as corresponding expressions of human genius and, like the rest of them, the artist expresses by his treatment not merely his subject but also himself. His true aim is not a perfect autochrome but something that through the material displays the

divinity that shapes his ends and ours. His claim that he can paint only what he sees must be set aside. Through the pictures we can obtain a sort of line spectrum of the artist. There is a good deal of interest in carrying that idea with one through the Academy exhibition. Of course the artist is not everything; the sitter as the medium of expression counts for something. It is clear from the exhibition that men are mostly clothes, sometimes little else, and women, with here and there an exception, are jewel stands. Clerics have a strong vein of pessimism, with the exception of the Bishop of Worcester; 'dons' are complacently resigned; politics, commerce, and industry are built up round an artificial smile; and marquesses are sly—very sly. But in spite of these intrusions into the natural spectrum we have to ask ourselves what are the lines belonging to the artist. For Orpen there is a strong line of realism and humanity towards the infra-red; he even goes so far as pinning down the unavoidable humanity of Miss Penelope Lawrence, M.D. (143), though he excuses women more easily than men. So does Sir John Lavery. Outside humanity there are not many lines in Orpen's spectrum. We can find more in Jack's picture of H.M. The Queen (133),

and still more in his "The Blue Drawing-Room, Buckingham Palace" (103). There is something, too, in La Thangue's "Tying Watercress" (255) and Mrs. Dod Procter's "Morning" (735). W. W. Russell's spectrum is so nearly continuous that he seems to be waiting for a reincarnation either of himself or his sitters to suggest a relation of life's enigmas.

If a crowd round a picture at the private view is any clue to its greatness, "Paolo and Francesca" (179), by F. Cadogan Cowper, seemed to be the favourite, and certainly it is an impressive scheme of colour; but still more on the side of the mystery of divinity is "The Enchanted Road" (350), by F. O. Salisbury, or "Svilata, Avati and Augali Sen, Daughters of Mr. and Mrs. Rimsod Sen" (652), by the same artist, and Clausen's "The Nut-brown Maid" (566). The mystery is not confined to portraits; it is quite impressive in "Theatre Marcellus" (75), by Sydney Lee, though the picture belongs to the red end of the artistic spectrum. But spectrum analysis of character is a perplexing study. Those who visit the Academy may take with them their own instruments. "Quai des Grands Augustins, Paris" (86), by Charles Cundall, is good for demonstration.

Obituary.

PROF. E. H. STARLING, C.M.G., F.R.S.

A FEW days ago news was telegraphed from Jamaica that Prof. Ernest Starling died on board the *Ariguai* shortly before reaching Kingston. Of late years he had had indifferent health and had suffered from disabilities under which one of less heroic spirit could not have continued to work strenuously. His enthusiasm for the discovery of new truths was unimpaired, and his mind was so sympathetic and alert that it was difficult to believe he was not a sound man. Nevertheless, evidences of diminishing capacity for work without undue fatigue were obvious to his friends and a source of anxiety to them.

At the close of the winter session, during which he had been daily occupied with arduous experiments, he was very tired. The weather was cold and dull, and he longed for sunshine and warmth. He therefore decided to take a voyage to the West Indies, in full hope that this would restore his energies and enable him to continue with enjoyment the experimental work with which he was occupied. However, that was not to be, but he had the satisfaction of going down with his flag flying, as he would surely have desired.

Ernest Henry Starling was born in 1866. His father, H. H. Starling, was Clerk of the Crown at Bombay. The family of seven children had perforce to be educated in England. They therefore saw but little of their father and were brought up by their mother, an extraordinary woman, and it is to her influence by heredity and nurture that Starling owed his determination, mental alertness, and much of his charm. As the eldest boy, in the absence of a father he early acquired a sense of responsibility and capacity for managing his affairs, and was, in some respects, unusually mature

for his years. He was educated at King's College School. He left at 16½ years of age, having matriculated at the University of London with honours, and proceeded to the study of medicine. He chose Guy's Hospital because his uncle was a Guy's man.

At this time Starling's ambition was to be a physician and live in Harley Street, and it was not until a few years later that he began to doubt the all-sufficiency of this ideal and to contemplate the possibility that he might be able to devote himself to an academic career and perhaps become a discoverer himself. As soon as he touched the study of natural science it was clear that Starling had found his *métier*. The causal relation of facts enthralled him. He was intensely curious, and had a naturally scientific mind. He was gifted with fine intellectual machinery, a good memory, industry, and possessed great powers for work, and it was soon clear to his teachers that they had a very exceptional pupil. The teachers of natural science at Guy's in those days were men of distinction, but they only called for a few hours weekly to deliver their lectures. The one who made a great impression upon Starling was Dr. Debus, of the Royal Military Academy, Woolwich, who gave part of the lectures on chemistry. He was a fine teacher, and the enthusiasm with which he expounded the elements of chemistry was infectious.

At the examination in preliminary scientific subjects at the University, Starling obtained the first place in chemistry and botany and second place in physics. He obtained so many medals and prizes as he proceeded through his medical course that an account of these academic victories at university and hospital would be wearisome. About two-thirds of the academic honours available

were secured by him, including a free studentship at Guy's Hospital. These various college and university scholarships sufficed to maintain him, and if he had liquidated the many gold medals awarded to him he would have been able to enjoy comparative affluence.

Physics and chemistry attracted him and the generalisation of biology, but it was when Starling came to study physiology that he met his fate. It cannot be said that his affection for physiology was due to his teaching at the Hospital. It was largely his own discovery, but Foster's text-book made a great impression upon him. After two years' study of physiology, during which he read many original papers, including all the back numbers of the *Journal of Physiology*, he had determined, I think, to become a physiologist, if such a career was economically possible. He had felt the deprivation due to his inadequate knowledge of German, so, after disposing of his second technical examination in 1886, he went, largely with the idea of improving his German, for a few months to Heidelberg, and worked in Kuhne's laboratory. He returned at the end of the year with his hair *en brosse*, much teutonised, and more than ever determined to become a physiologist. However, he had to put these aspirations aside for a while and devote himself to the study of practical medicine. This he did with his usual enthusiasm. Starling found great satisfaction and enjoyment in clinical work. The human side appealed to his sympathetic nature and the immediate value of the application of knowledge to his practical mind. If it had been possible to devote himself whole-heartedly to the study of medicine, as is now possible by the institution of full-time professorships, Starling would have been as happy investigating disease as in a physiological laboratory. Indeed, not many years ago he seriously considered accepting such a position.

Having completed his medical studies and occupied the position of house physician and house surgeon at the hospital and graduated M.D., Starling was confronted with the problem, how he was to live if he were to follow his desire and devote his life to physiology. With his brilliant career at the hospital, the profession of a physician was open to him and success undoubted. He was keenly interested in medicine and pathology, and the temptation to follow the line of less resistance and greater promise of reward was considerable. However, in 1889 he determined to try the rougher path, and became demonstrator in physiology. The rewards of this office were minute, and Starling told me that he owed the possibility of giving his allegiance to science to a British Medical Association Scholarship for medical research. The Scholarship was worth £150 a year, and this addition to his slender salary kept him going. Next year, owing to the death of Wooldridge, a vacancy as joint lecturer on physiology occurred and Starling was appointed. On the termination of the British Medical Association Scholarship he was appointed to the research scholarship of the Grocers' Company of the value of £250 per annum. It was not then

so easy to embark on a scientific career without financial resources as it is now, and it is terrible to think how one of Starling's glorious attainments was nearly deterred.

He was confronted, not only with the problem of how he was to continue to subsist on one-third of a salary which was never intended to command the whole services of a physiologist, but also how he was to secure a physiological laboratory to work and teach in. The Grocers' scholarship temporarily solved the first problem, and he determined that adequate accommodation and equipment for teaching and research in physiology should ere long, by some means, be obtained. Meanwhile, being but one of three joint lecturers, he was able to arrange to go and work abroad occasionally. In 1893 he went to Breslau to work with Heidenhain, and later for a few months to the Pasteur Institute, as he was greatly impressed by Metchnikoff's discoveries about phagocytosis. In order that this work might be more available to English students, he and his wife translated Metchnikoff's lectures on comparative inflammation.

Until his hopes for a physiological laboratory should materialise, Starling did his best to secure some improvement of the arrangements for practical teaching and demonstration with the funds available; meanwhile he repaired to Schafer's laboratory at University College to carry on his researches. Bayliss was also working in the laboratory, and here began a scientific partnership which lasted on and off for thirty years. The two complemented one another in many respects. Whilst both possessed scientific imagination of the highest order, Starling was more ardent and forceful, eager to translate ideas into action, but rather bored with details of technical method. He had never been interested in doing things with his hands, except climbing, although later he became a most beautiful and dexterous operator. Bayliss was the philosophical student, calm, with better critical judgment. He read widely and had a wonderful knowledge of scientific literature, was an excellent mechanic, and found enjoyment in the development of the technical methods of research. How fruitful this partnership was will be seen from the account below of Starling's scientific work.

The equipment at Guy's Hospital steadily improved, and Starling and Bayliss did their work on the innervation of the heart there. By 1895 Starling had planned a really good physiological institute for Guy's Hospital, and secured the assent of the authorities to its erection. These laboratories were completed in 1897 and were, at that time, the best laboratories for physiology in London. The amount of time and effort involved in this accomplishment was considerable. Unwilling authorities had to be persuaded to provide territory and funds and colleagues to make sacrifices of their own legitimate aims, and although it was becoming recognised that Starling was going to be a great man and was an ornament to the staff, this was no easy matter.

Not long after the opening of the new physiological laboratories at Guy's Hospital, the Jodrell

chair of physiology at University College fell vacant owing to Schafer's acceptance of the professorship at Edinburgh. In 1899 Starling was appointed. It was a wrench to leave his fine new laboratories, to the construction of which he had devoted so much time, but the emoluments of the Jodrell chair were greater, and the conditions at University College he deemed more favourable to the realisation of his ideals. Moreover, he was determined that it should not be many years before he would have a new Institute of Physiology at University College, for the planning of which the Guy's laboratories would have served as useful exercise.

This determination came to fruition in 1909, when the present fine Institute of Physiology was opened. Starling's plan was not merely for a new physiological school, in which he was naturally more particularly interested, but he wanted all the medical sciences at University College to have the advantages of more commodious and nobler buildings. His original scheme was for an Institute of the Medical Sciences, including anatomy and pharmacology as well as physiology, with a central library, pathology being well housed in the new Clinical School. At first only the physiological section was built, but a few years ago the erection of the whole institute, as originally contemplated, was rendered possible by a generous gift from the Rockefeller Foundation, the directors of which were desirous of devoting funds in the interest of medical science in London. That they chose this particular means of fulfilling their aims was largely, if not entirely, due to Starling, and the noble Institute of Medical Sciences with which University College is now endowed is a fine material monument to the memory of one who not only helped to build up a great school of physiology in London and obtained an appropriate habitation for it, but also was as unsparing in his efforts to secure similar advantages for the other medical sciences.

In 1923 Starling retired from the Jodrell chair and was appointed to a Foulerton research professorship of the Royal Society. He still continued to work at University College, but was relieved of all administrative duties and all teaching except that of a small band of research pupils. His laboratories continued to be a centre of great activity, and a limited number of distinguished young physiologists from Great Britain and abroad still enjoyed the advantage of working in close communion with one of the greatest masters of experimental physiology. It was a happy family.

STARLING'S PHYSIOLOGICAL RESEARCHES.

"Only by following out the injunction of our great predecessor [Harvey], to search out and study the secrets of Nature by way of experiment, can we hope to attain to a comprehension of 'the wisdom of the body and the understanding of the heart,' and thereby to the mastery of disease and pain, which will enable us to relieve the burden of mankind." (Starling, Harveian Oration, Royal College of Physicians, 1923.)

Starling's interest in physiology was general, but the subjects for investigation which particularly attracted him were those physiological processes which seemed

capable of interpretation in terms of chemistry and physics. Whilst realising that adaptation was the essence of organism and had no counterpart in inanimate nature, he had not much sympathy with the neo-vitalists. In his view, if the contraction of muscle was not understood, it was because we did not know enough about physics and chemistry or about muscle.

He was always, from his student days, fascinated with the problem of the heart and the adjustment of its action to varying conditions of the body, and his first paper, written with Bayliss in 1891, was on the electromotive phenomenon of the mammalian heart. Waller had recently studied the electrical variation of the excised heart and also of the heart *in situ* by leading off from the neighbourhood of the apex and base respectively. It was evident to Starling that by photographing the movements of the capillary electrometer, connected with electrodes placed in different positions on the naked heart in the anaesthetised living animal, much might be learnt of the nature of the cardiac contraction: in fact, that a new method of observation was at the disposal of the investigator. At that time, any sort of muscular continuity between the auricles and ventricles was denied, and the view that conductivity was due to some nervous network supplying the fibres was in favour. In this research he enjoyed the co-operation of Bayliss. They set out to ascertain the course and time relations of the wave of contraction in the ventricle, the nature of the transmission from auricle to ventricle and throughout the ventricle, and to examine critically Frédéricq's reasons for regarding the nature of the ventricular contraction to be tetanic.

They succeeded in showing (1) that the ventricular contraction is a single wave starting from the base; (2) that there is a natural block at the auriculo-ventricular groove; (3) that the rate of transmission of the contraction wave is about 5 metres per second. This sounds commonplace at this time, when the electrocardiograph is in general use for clinical diagnosis, but their observations not only formed an important step in the development of our knowledge of cardiac contraction and in the interpretation of disease of the heart, but also, by showing what valuable information could be obtained by the electrical method, stimulated its employment and accelerated the development of the electrocardiograph.

They next explored the separate action of the vagi and accelerator nerves on the auricles, on the ventricles, and on the conducting power of the auriculo-ventricular junction in the mammal. The effects of these nerves on the hearts of frogs and tortoise had been previously studied by Gaskell and Heidenhain, and that of the vagi upon the auricle of mammals. Bayliss and Starling completed the story, showing that there was no essential difference between the hearts of mammals and cold-blooded animals, and that the vagus depresses conduction in auricle, auriculo-ventricular junction and ventricle, and that the accelerator nerves had the opposite effects on all three structures.

Two other important papers dealing with the mechanism of the circulation were published by Bayliss and Starling at this time. One was an exhaustive study of the simultaneous changes in the arterial and venous pressures of various regions of the body under a great variety of experimental conditions. The results showed the universal applicability of the principle of the circulation worked out by Ludwig. They said, in their paper, that the effects produced were such as might have been predicted by any one with a knowledge of the elementary principles of the circulation. However, nobody had predicted them.

The last contribution of this first series of papers on the circulation was an analysis of simultaneous pressures in the aorta and ventricles of the heart *in situ*, by an ingenious method which was a vast improvement on any hitherto devised. They used a continuous photographic record of the changes in volume of a small air-space at the end of a capillary glass tube connected with the aorta and ventricle respectively. This method was free from inertia and aperiodic, and they succeeded in obtaining a true record of the rapid variations occurring in the ventricle and aorta and the precise relation of these to one another. Their measurements have been the standard of reference ever since.

TRANSUDATION FROM THE VESSELS AND LYMPH-FLOW.

In 1892, Starling, for a while, relinquished the study of the blood circulation and turned his attention to the mechanism of lymph flow. The conditions determining the equilibrium between the liquids in the blood-vessels and tissue spaces required exploration. Was lymph a transudation or an excretion? Heidenhain had recently published a stimulating paper on lymph formation, in which he concluded that normally filtration played no part in the formation of lymph, so in 1892 Starling went to work in the Breslau laboratory.

Heidenhain had distinguished two kinds of lymphagogues, and under his inspiration Starling set to work to make a more detailed analysis of the effects of one of them, peptone. In summarising his results he adopted the interpretation of Heidenhain that the experimental facts concerning lymph formation could not be explained by filtration and that it was necessary to suppose a selective activity on the vessel wall. However, on returning to England he continued to work energetically at the problem of lymph formation and repeated all of Heidenhain's experiments. He was able to confirm his facts but came to doubt the correctness of his interpretation. He searched for evidence of lymph-secretory nerves, but found that the nervous system could only influence lymph flow by altering vascular conditions. After years of experimenting he came to the conclusion that it was unnecessary to suppose a secretory activity of the endothelium, and that there was no experimental fact inconsistent with the view that lymph formation was a function of two factors, permeability of the vessel wall and intracapillary pressure. Nevertheless, there were a number of observations equally unintelligible on either hypothesis, and further work with Leathes and Tubby on the absorption of various solutions from the pleural cavities only emphasised that there was yet another factor concerned in determining whether fluid passed in or out of the capillaries.

In 1896 Starling discovered that the missing factor required to afford a complete interpretation of the phenomena was the osmotic pressure of the colloids, to which the walls of the capillaries are relatively impermeable. It had hitherto been supposed that the osmotic pressures of proteins, being so insignificant compared to those of salts, must be of no account in physiological processes. The reverse is indeed the case, because it is only to the proteins that the membrane is impermeable. He therefore set to work to measure the osmotic pressures of the proteins in serum and found them to be, though small, of the order of magnitude of the capillary pressure. The problem was solved. The hydrostatic pressure and the osmotic pressure supplied the balance of forces necessary to explain the experimental observations. These, together with altered permeability of the endothelium, are capable of supplying a reasonable inter-

pretation of œdema and pleural effusion, and formed the subject of his Arris and Gale lectures to the Royal College of Surgeons in 1926.

Starling's work on lymph formation occupied five years, and is of the best he did. After long-continued and difficult experimentation, combined with observation of the highest order of accuracy, this hitherto obscure but fundamentally important region of physiology was finally illuminated by his dexterous experimentation and triumphant imagination.

THE MOVEMENTS AND INNERVATION OF THE INTESTINES.

When Bayliss and Starling undertook this study, the nerve supply to the small and large gut had been carefully determined by Langley and Anderson, but of the working of the neuromuscular mechanism there were many discrepancies as to fact and opinion. After eighteen months' careful experimenting, with appropriate recording methods devised for the purpose, they were able to reduce the previous chaos to order and to summarise the main facts concerning intestinal movements in a few simple statements. (1) That peristaltic contractions are true co-ordinate reflexes carried out by the local nervous mechanism and independent of the connexion with the central nervous system. (2) Local stimulation of the gut produces excitation above, inhibition below. (3) Besides the local mechanism, every part of the gut is subject to the control of the central nervous system through the splanchnics and vagi, the former being inhibitory and the latter containing both augmenting and inhibitory fibres. This was as far as understanding of the matter progressed until Cannon introduced the method of observation by means of X-rays in an animal fed upon a bismuth meal.

PANCREATIC SECRETION.

The discoveries of Pawlow had determined the order of events in gastric secretion and their co-ordination through the agency of the nervous system, but although he had found that no secretion from the pancreas occurred until the acid chyme reached the duodenum, just how pancreatic secretion was called forth in an appropriate manner had baffled this great experimenter and his pupils. Popielski had determined that the introduction of acid into the upper part of the small intestine caused secretion from the pancreas, notwithstanding previous section of the vagi and sympathetic or even complete extirpation of the solar plexus. He concluded, therefore, that secretion must be brought about reflexly, by means of some local nervous apparatus.

Bayliss and Starling started their investigations with the idea of deciding where this peripheral nervous mechanism was. They verified all the facts stated by the Russian physiologists but were unsuccessful in proving the existence of any nervous mechanism controlling pancreatic secretion. Nor could they discover how secretion was brought about until they made the crucial experiment which led to the discovery of secretin.

It happened to be present at their discovery. In an anaesthetised dog, a loop of jejunum was tied at both ends and the nerves supplying it dissected out and divided so that it was connected with the rest of the body only by its blood-vessels. On the introduction of some weak hydrochloric acid into the duodenum, secretion from the pancreas occurred and continued for some minutes. After this had subsided, a few cubic centimetres of acid were introduced into the enervated loop of jejunum. To our surprise, a similarly marked secretion was produced. I remember Starling saying, "Then it must be a chemical reflex."

Rapidly cutting off a further piece of jejunum, he rubbed its mucous membrane with sand in weak hydrochloric acid, filtered and injected it into the jugular vein of the animal. After a few moments, the pancreas responded by a much greater secretion than had occurred before. It was a great afternoon.

Bayliss and Starling followed up their discovery in many important directions which space forbids me to mention. A method of obtaining natural pancreatic juice was now available, and they made full use of their opportunities to study trypsinogen and its conversion into trypsin by enterokinase. Their observations were afterwards summarised and their significance illustrated in their Croonian lecture to the Royal Society in 1904.

Starling was also moved by them to much constructive thought and further research on the chemical integration of the bodily functions generally. He proposed the name 'hormones' or chemical messengers for all such active principles formed in one part of the body and distributed by the circulation to excite the normal functioning or stimulation of growth of other parts. This fascinating story, embellished with a wealth of illustration, formed the subject of his Croonian lectures to the Royal College of Physicians in 1905, entitled "The Chemical Correlation of the Functions of the Body."

RESEARCHES UPON THE ISOLATED HEART.

The behaviour of the heart had interested Starling from the time he was a house physician. His earliest work was upon the heart, and though he diverged into other fields of investigation, the questions which intrigued him at that time always retained their fascination. In 1909 he returned again to their investigation. He had been attempting to dissociate the effects of asphyxia on the circulation into those due to diminished oxygen and increased carbonic acid tension respectively. He used the 'spinal animal,' that is, one in which the brain above the pons has been destroyed. He obtained some interesting information, but the observations were difficult to interpret until he should be able to separate the effects of alteration in the gaseous composition of the blood upon the heart itself.

To arrive at this, it was necessary to be able to record the influence of variations of carbon dioxide and oxygen upon the mammalian heart isolated from the nervous system and not subjected to any simultaneous modification in its nutritive state, in the inflow of blood, or in the amount of work it was called upon to do. To satisfy these requirements the heart must be isolated from the rest of the body and at the same time fed with a constant supply of perfectly oxygenated blood; it must be working under mechanical conditions completely under the control of the experimenter. This was accomplished by a device, now famous, known as Starling's heart-lung preparation, in which the lesser circulation is intact, but the only paths from the left ventricle to the right auricle are (1) through the coronary arteries, (2) through an artificial connexion in which the resistance can be regulated. By appropriate means the pressure and flow in different parts of the circulation can be recorded and also the volume of the blood circulation per unit time and the work done by the heart. If required, the gaseous metabolism of the heart contracting under various conditions can be studied. The limited amount of blood in circulation permits analysis of its contents from time to time. Further, the method is admirably adapted to the observation of the direct effect of drugs, etc., upon the mammalian heart, working under every conceivable condition. Nor does this exhaust the possibilities of Starling's heart-lung

preparation as an engine of research into cardiological problems. The flow through the coronary circulation can, if necessary, be diverted and measured so that change in the blood-supply to the cardiac muscle can be determined.

After the perfection of this technique, a series of discoveries were made by Starling and his pupils, which, in conjunction with those of Lewis, have made the laboratories of University College as famous a focus of research upon the circulation as was the laboratory of Carl Ludwig sixty years ago.

The years immediately succeeding the development of this method of studying cardiology were the most productive, from the point of view of scientific output, in Starling's career. He was surrounded by enthusiastic and devoted pupils drawn from all over the world. He had plenty of problems for them to attack, with every prospect of a reasonable reward for their efforts. Starling was unsparing in helping them towards their solution, often performing the more difficult parts of the experiments himself and afterwards writing their papers for them.

It is only possible to indicate the principal researches undertaken and the more fundamental facts established by this happy band of discoverers until it was scattered by the outbreak of war in 1914. Detailed accounts will be found in the publications from his laboratory between the years 1910 and 1915. They are in no case merely qualitative observations but quantitative determinations. They occupy hundreds of pages of the *Journal of Physiology* and other periodicals during this period. They show the marvellous power of the heart, apart from the nervous system, to adapt its work in accordance with the needs of the body as a whole, and also the exquisite mechanisms to enable it to do this within wide limits, without embarrassment or permanent injury.

In the first case the effects of variations in the tensions of oxygen and carbon dioxide in the blood upon the diastolic volume and output of the heart, on its capacity for work, and on the flow through the coronary arteries, were determined. The heart was found to have an astounding power of utilising the oxygen in the blood. When an isolated heart was fed with blood from an asphyxiated animal, the heart removed all but traces of oxygen. The conditions controlling the rate of the heart-beat were studied, and the only influences found to modify the rate of the isolated heart were temperature, the volume of the inflow, and adrenalin. The maximum output of the heart was measured and found to be three litres a minute for a dog's heart weighing 50 gm. Important observations were also made upon the energetics of the heart by determining the oxygen used per unit of work done. The respiratory quotients of the normal and diabetic heart were determined, and from these two sets of observations the efficiency of the heart as a machine working under various loads was determined. The ventricular output was discovered to be independent of the arterial pressure, but, on the other hand, it was found to be dependent upon inflow. From this it appeared that as the heart dilated and its fibres were stretched, it worked with greater efficiency. This was afterwards shown to be the case by his distinguished pupil Lovat Evans.

The experiments upon the flow of blood through the coronary arteries showed that this flow was primarily dependent upon the arterial pressure, but that dilatation of the coronary system occurred when the carbon dioxide tension in the blood increased, when adrenalin was added, and most markedly when some metabolites, the product of the heart's own activity, were added to the blood circulating. In the latter circumstances the increased flow through the

coronary arteries was out of all proportion to the pressure in the aorta, a further indication of automatic adjustment to a condition of stress.

Starling having supplied us with a new method of inquiry, many competent physiologists could have ascertained much of the information outlined above, but there was one discovery which is peculiarly the product of his genius, namely, that cardiac muscle, like voluntary, contracts more forcibly as it is stretched even up to the point when the texture is fractured. Therefore to work at greatest efficiency a heart must first dilate, which it inevitably does, as the pressure in front of it increases. This is what Starling calls the "Law of the Heart." As he said in the fine Harveian oration he delivered before the Royal College of Physicians in 1923, when he expounded in simple and beautiful language the results of his researches into the movements of the heart, "The heart has thus the power of automatically increasing the energy evolved at each contraction in proportion to the mechanical demands made upon it, behaving in this way almost like a sentient, intelligent creature."

STARLING'S SERVICES DURING THE WAR.

After War broke out Starling became very unsettled. He wanted to go and fight. Persuaded, if not convinced, that this was not the most suitable manner in which to satisfy his strong tribal instincts, he joined the R.A.M.C. as a Captain and was for some time a medical officer at the Herbert Hospital. Later, as the scientific resources of the country were mobilised, he was made Director of Research at Milbank and was busy experimenting with defensive methods against poison gases. In this he rendered invaluable service to his country, and no one could be better to control a research laboratory. However, at the end of 1916 he was exalted to the rank of Lieut.-Colonel and sent as Chemical Adviser to Salonika, where he had nothing to do. Maybe his impatience of official methods had embarrassed the authorities. In 1917 he resigned his commission, deeming that he could be of greater service as a civilian.

At that time food-shortage seemed most likely to decide the issue, and Starling became chairman of the Royal Society Food Committee and was largely responsible for the value of the advice given by it to the Government. Afterwards he was scientific adviser to the Ministry of Food, and British scientific delegate on the Inter-Allied Food Commission.

In all these capacities Starling rendered yeoman service. He soon had a mastery of the necessary facts, and he was by nature and training able to marshal them comprehensively and arrive at definite conclusions. He was never 'hivering,' and he impressed all those statesmen and officials with whom he had to deal. It is doubtful whether any other of our physiologists could have served us so well.

LATER RESEARCHES ON THE CIRCULATION.

For a while, after the War, Starling's work was seriously curtailed owing to ill health, which finally necessitated a serious surgical operation. However, in 1920 he was back again at work, with Anrep, on the central and reflex regulation of the circulation by an ingenious cross-circulation method built up on his heart-lung preparation. In this method the circulation through the brain of an animal is entirely under the control of the experimenter, while the animal's own heart supplies the rest of its body.

A notable discovery was that, whereas rise of aortic pressure leads to dilatation of the blood-vessels so long as the depressor nerves are intact, change in the blood-pressure in the supply to the brain produces the reverse change in the pressure of the rest of the body.

These fundamental laws of vasomotor regulation were suspected but never before established.

THE SECRETION OF URINE BY THE ISOLATED KIDNEY.

The heart-lung preparation affords a means by which any isolated organ may be fed with arterial blood of known composition at any desired pressure, rate of flow, and temperature. It is thus possible to study the functions of an organ apart from nervous influences and from the chemical influences which may arise in consequence of modifications in the blood caused by other organs of the body. After numerous attempts, Starling and Verney succeeded in maintaining the isolated kidney in such a condition that it would secrete abundant urine.

By this method, which demands extraordinary experimental skill, Starling has opened a new chapter on the physiology of renal secretion. Already, many new facts, and others which were previously only matters of surmise, have been discovered and established. His observations with Verney and in collaboration with Eichholtz have shown that the glomeruli filter from the blood plasma its non-protein constituents, and that by using hydrocyanic acid to suspend tubular activity, a pure glomerular filtrate is obtained from the ureter. Also that, whilst urea and sulphate are secreted by the tubule cells, water, chloride, bicarbonate and glucose are re-absorbed by the tubule cells from the glomerular filtrate. Pituotrin increases the amount of chloride and decreases the amount of water eliminated.

The influence of the pituitary gland upon the secretion of the kidney was particularly studied by Starling's pupils, Eichholtz and Bruhl. Their experiments suggest that the inability of the isolated kidney to secrete inorganic phosphate is due to the absence of the pituitary hormone. If this be so, it is another discovery of a chemical correlation of the body for which Starling is largely responsible.

These researches on the isolated kidney were in full swing in April when Starling left for the holiday which was long overdue. They were affording most important results, and doubtless, had he been spared to continue them, he would, with his unrivalled experimental skill, ultimately have succeeded in clarifying our knowledge of urinary secretion as he had laid bare the principles involved in the self-adjustments of the heart to physiological requirements.

STARLING AS A TEACHER.

Starling was a fine teacher. He had not a natural gift of oratory, but by practice he early became a good, coherent and agreeable speaker. He had a happy way of finding telling phrases to emphasise the main points of his discourse, and sometimes, when feeling deeply, he was eloquent. His enthusiasm was infectious, and his pupils enjoyed his lectures. His influence as a teacher was, however, not confined to those who had the privilege of sitting at his feet. His "Principles of Human Physiology" is the best text-book on the subject in the English language, and is widely used by students on both sides of the Atlantic. It has also been translated into Spanish. As a teacher to research students he was ideal. He loved the companionship of young men. To every one, provided only that he were a serious inquirer after truth, he was ready to extend help, encouragement and friendship.

An account of Starling's scientific career would

be incomplete without allusion to the part played in it by his wife. In 1891 he married Florence Wooldridge, the daughter of Sir Edward Sieveking. They were inseparable companions. With unselfish devotion she helped him more than will ever be known. They discussed all his projects together, and for many years she performed for him all the functions of an efficient secretary. Further, in addition to the responsibilities of bringing up their four children, she bore on her shoulders the burden of the humdrum duties of his life, thus releasing the more energy for his work.

Starling was the recipient of many academic honours. Honorary degrees were conferred upon him by the Universities of Dublin, Sheffield, Cambridge, Breslau and Heidelberg. He received the Baly Medal in 1907 and the Royal Medal of the Royal Society in 1913. What place amongst the

great discoverers in medical science should be allotted to Starling must be left to the judgment of posterity, but it will be generally conceded by his contemporaries that he was one of the foremost physiologists of our time, and that no one since Harvey has so greatly advanced our knowledge of the action of the heart.

Although no man gave more devoted service to science, Starling's interests were many-sided. He loved music, he loved beauty, he loved a fight; in fact, he loved life. The great charm of his companionship was, in part, due to his extraordinary mental alertness and boyish enthusiasm; like Peter Pan, he refused to grow old. His death means a sad loss to all of us and will be felt not least by the generations of pupils who have been his companions during his lifelong search for new knowledge by experiment. C. J. MARTIN.

News and Views.

IN a supplement to NATURE for July 3, 1926, Dr. G. E. Hale described his recently completed spectrohelioscope—a visual instrument for observing solar phenomena in monochromatic light—and indicated its large scope in exploring the higher parts of the sun's atmosphere. On p. 708 of our issue this week, Dr. Hale gives us some of his results obtained during the last few months from observations of the hydrogen gases involved in the upper part of the vortex of a sunspot and its attendant region of disturbance. The particular problem to which he has applied his instrument is to determine whether the characteristic appearance of whirl-formation of the hydrogen flocculi surrounding sunspots is hydrodynamical or electromagnetic in origin. These hydrogen whirls, depicted on photographs taken in monochromatic light of H α by the spectroheliograph, had previously been closely studied by Dr. Hale, who found the evidence inconclusive for an explanation of their exact nature, for they appeared to be unrelated to what is presumably a periodic reversal every 11½ years of the direction of whirl of a deeper-seated vortex which gives rise to the magnetic field of a sunspot. He is now able to show in the present article that his recent observations afford a more critical test, which proves to be against the electromagnetic explanation. He states, however, that there still exist several difficulties in the way of explaining the structure of the flocculi along purely hydrodynamical lines.

ONE great advantage of the spectrohelioscope is that it permits the observer to watch continuously the movements of the solar gases, and by means of a 'line-shifter'—a neatly devised accessory—the radial velocity of separate portions of a flocculus can readily be estimated. Although photographs of hydrogen flocculi strongly suggest movements of inflow or outflow, the reality of such motions has, as a general rule, been difficult to establish even from a long series of daily spectroheliograms or from others taken at shorter intervals. With his spectrohelioscope, Dr. Hale has now seen a number of these flocculi being drawn into spots with accelerated velocities, in one

instance increasing from 22 to 50 km./sec. at corresponding distances of 56,000 km. and 20,000 km. from the centre of the spot. These and other observations of moving masses of gas in the near vicinity of spots have an important bearing on the motions of related prominences which have been recorded from time to time. The possibilities of this instrument and the remarkable observations which have already been made with it are of the greatest interest.

THE commemoration of Huxley's birthday by an annual lecture delivered at the College with which most of his teaching life was associated, is a new institution, which the Imperial College of Science owes to its Rector, Sir Thomas Holland, who himself was an old pupil of Huxley's. The first lecture in the series was delivered by Prof. E. B. Poulton in 1925 and was of a charming and intimate biographical character. The second lecture, by Dr. P. Chalmers Mitchell, should have been delivered last year, but had to be postponed owing to the general strike. It was delivered on May 4 of this year. Dr. Mitchell took as his title, "Logic and Law in Biology," and, as was to be expected, he delivered an admirably lucid and incisive address. Dr. Mitchell's thesis was that it is a weakness of the human mind to invent imaginary entities to account for the flux of things, and that of these entities the idea of 'law' is the most universal. He pointed out that Huxley had said that every law is a construct of the human intellect, and no more exists outside us than does colour. Dr. Mitchell then went to scourge the concepts of 'vitalism,' 'orthogenesis,' and 'emergent evolution.' If we get rid of all these conceptions, what remains? According to Dr. Mitchell, an increase of 'plain materialistic explanation.' But many will ask: Is not 'materialistic explanation' itself an imaginary concept? There was, in fact, an aura of nineteenth-century materialism and scarcely veiled 'episcopophagy' about Dr. Mitchell's address which was admirably in keeping with one phase of Huxley's character. But the same Huxley who on one occasion said that it was as absurd to talk of the

'vitalism' of an animal as of the 'horology' of a clock, on another occasion declared that he was not a materialist because he could not conceive of matter apart from mind to picture it in.

DR. CHALMERS MITCHELL referred to biogenesis—the chief stumbling-block in the way of the thorough-going materialist. He pointed out that Huxley fully admitted that all life comes only from pre-existing life, but that he claimed the right to 'imagine' a condition in the past when life had arisen from dead matter. If science is the determination and measurement of the processes going on now and their imaginary prolongation into the past and the future, and if this procedure leads to the inference that a discontinuity occurred, then the scientific attitude is to recognise frankly that this is so. To say that it could not have been so, is to introduce an *a priori* conception such as Dr. Mitchell justly deprecates. Indeed, many biologists will maintain that Lord Kelvin's famous assertion that there are in the history of the universe at least two discontinuities which the theory of development cannot get over, namely, the primary concentration of energy and the beginning of life, remains as justified to-day as when he made it. Dr. Mitchell referred to numerous investigations which he claimed are reducing the gap between the living and the non-living. To the opposite school of thought the trend of the recent investigation is not in this direction. A few years ago it was thought that *Amœba* could be successfully imitated by a drop of rancid oil, and that all its motions were due to surface tension; now, a recent investigator tells us that if *Amœba* were the size of a dog, no one would refuse to call its actions intelligent.

BIOLOGISTS will be surprised to learn that Prof. Julian S. Huxley is resigning the chair of zoology in King's College, London, to which he was appointed less than two years ago. We understand that Prof. Huxley will still continue to be attached to King's College in an honorary capacity, but he intends to devote himself entirely to writing and research. Thus a new situation is created with regard to the purveyors of knowledge and their relation to academic institutions, a situation which all who are concerned with the spread of knowledge will do well to examine thoroughly. With the spread of popular education and the use of applied science there has come into existence not only a large body of the general public which desires further knowledge, but also, in the shape of cheap printing, broadcasting, instructional films, and the systematisation of popular lectures, the means for gratifying this desire without recourse to formal lectures at a college or university. The use of broadcasting and the cinematograph is now being officially encouraged for instruction in schools. The successful 'libraries' issued by various publishers, such as the Home University Library, Benn's new Sixpenny Library, and other similar ventures, show what can be done with educational series; works like Wells's "Outline of History," what can be done with the single book; the University Extension Lectures

and the classes arranged by the Workers' Educational Association—which some members of the Royal Commission on Oxford and Cambridge thought the most important innovation in university practice which had ever occurred—the Chautauqua, the organised lecture-tours of the United States, what can be done with lecturing partly or wholly detached from academic institutions.

THESE gateways to knowledge are of great importance to the learner; but their importance to the teacher seem not yet to have been fully realised. They imply that an increasing number of those who are interested in teaching or in the pursuit of knowledge for its own sake will be able to make a livelihood without lecturing to students in a college or university. On the other hand, it will obviously be of advantage to such workers to be connected in some way with academic institutions, with their facilities for research and study and their atmosphere of learning; it will equally be of advantage for the academic institutions to be associated with any new means of spreading knowledge, and with any one, whatever his method of obtaining a livelihood, who desires to devote his energy to pure research. It will be interesting to see how educational organisation will adapt itself to the new situation which is thus arising, and in particular to follow the success of this new and courageous venture of Prof. Huxley.

IN the past twenty-five years, the Appointments Board of the University of Cambridge has effected quietly a noteworthy revolution in the attitude of tutors and undergraduates towards the business world and of the business world towards the universities. Where formerly men looked to an academic life, to the Civil Service, or to one of the professions as a natural sequel to a successful university career, now in growing numbers they are looking to the world outside, and the outside world is more and more seeking for men of proved ability with a university training. The immediate result is at present most apparent in the Far East, where, for example, Sir John Jordan has described the Cambridge graduates as having "changed the face of business in China," and where the great oil groups are relying with confidence to their staffs, mainly university men, to enable them to maintain their lead throughout the world. Firms and industrial organisations in Great Britain are also more and more inclined to turn to the universities for their administrative appointments, and along with this is a growing demand in industry for trained scientific workers for chemical, physical, geological, engineering, forestry, or agricultural work. The Appointments Board at Cambridge has, through its secretary, Mr. H. A. Roberts, gained the confidence of the business world and of Government departments, and serves now as the natural channel for meeting their demands. In meeting these demands satisfactorily it has also stimulated a wider demand. It will be of interest to watch in the coming years the reaction of this larger demand on the conditions of the alternative careers which are losing ground at present in the order of choice of the young graduate.

A PRELIMINARY programme has now been issued of the Leeds meeting of the British Association, to be held on Aug. 31-Sept. 7, under the presidency of Sir Arthur Keith. The president's address will be delivered in the Majestic Cinema, City Square, on Wednesday evening, Aug. 31, on the subject, "Darwin's Theory of Man's Descent as it stands To-day." Evening discourses will be given to members of the Association in the Albert Hall, Leeds, on Sept. 2 by Prof. R. A. Millikan on "Cosmic Rays," and on Sept. 5 by Dr. F. A. E. Crew on "The Germ-plasm and its Architecture." Public lectures are being arranged for Leeds and the neighbouring towns. Several excursions to local places of interest and to works and factories in or near Leeds are being organised, a civic reception will be held in the Art Gallery on Sept. 1, and the University will hold a reception on Sept. 6. The reception room during the meeting will be at the Town Hall; the local honorary secretaries for the meeting are Mr. James Graham and Prof. A. Gilligan, Education Department, Calverley Street, Leeds.

In the issues of the *Morning Post* for May 4 and succeeding days, Dr. T. W. Gann publishes a further report on his investigations of Maya ruins in Yucatan in the present season. Writing from Belize, he says that his last expedition has proved somewhat eventful, his larger motor boat having been wrecked and the smaller left behind badly damaged, while the greater part of his equipment has been lost. At Ambergris Cay, off the north coast of British Honduras, he found evidence that this island had once been inhabited by a branch of the Maya who had developed along lines of their own. They worshipped a god, a short, round-faced, masked individual like nothing known on the mainland. Dr. Gann's objective was Tuluum, where he proposed to visit the jealously guarded country of the Santa Cruz Indians, the only pure-blooded descendants of the ancient Maya. Before reaching Tuluum, however, he landed at a place called Majanal, just south of Espiritu Santo Bay, on a report from his pilot that there were ruins in the neighbourhood. A search revealed a city literally buried in sand, which lay in terraces. On the highest of these, huge square stones were still exposed. The preservative qualities of sand should make this a profitable site for future excavation.

ON reaching Tuluum he found the ruins cleared of vegetation, and learnt later from the chief of the Santa Cruz Indians, by whom he was most hospitably received, that although they had a chapel in their nearby native *pueblo*, the temple was held in veneration and used by them. Dr. Gann took part in an elaborate religious ceremony in the old Maya temple before a cross draped with a native woman's skirt, and before which *jabin* branches were placed, this being the herb held peculiarly sacred to their gods by the ancient Maya. The celebrant at the service was a woman, the widow of the priest who had recently died leaving a son too young to learn the prayers. She conducted the service in Spanish, although she knew no word of the language, but the responses were given in Maya. The service opened

with a fumigation of every one and the temple with aromatic resins to drive away the devils, and concluded with the drinking of a bowl of a mixture of ground corn and honey. Dr. Gann was able to collect much interesting information about the beliefs and customs of these survivors of the ancient Maya race, and obtained a unique photograph of the idol which they dread as an embodiment of evil.

AN interesting series of copies of frescoes from Theban tombs has been placed on exhibit in the British Museum on permanent loan. They have been executed by Mrs. N. de Garis Davies and belong to Dr. Alan Gardiner, but will ultimately become the property of the Museum. With the exception of copies made for the Metropolitan Museum of New York, this is the only representative collection of reproductions of this class of Egyptian art. The examples which have been chosen for exhibition go back in date to so early as 2150 B.C. They have been selected especially with the view of covering as wide a field as possible in illustration of the social life and history of the early Egyptians. The earliest example shows women baking cakes. A representation of women at a feast of 1420 B.C. is interesting as illustrating the custom of placing solid unguents on the head at a feast, which melted and ran down over the hair, face and even garments. The motives of conventionalised spirals and lotus flowers used as the decoration of the ceilings of tombs are illustrated in frescoes of about 1300 B.C. A cat seated beneath the chair of its mistress and another eating fish, from the tombs of the astronomer Nakht and the Harbour Master are successful examples of Egyptian realism, more happy, indeed, than the leashed hound from the tomb of Rekhmire. Paintings showing relations with Crete are well represented. A drawing from the tomb of Tut-ankh-amen's governor of Syria will no doubt prove attractive on the ground of its associations. Among other features represented are negroes carrying tribute, and Ethiopians with cattle having fetishes on their horns, golden rings and a giraffe. There are also shown cattle, mourning women in a boat, and Kenre and his wife Mutemnia drinking from a pool in the fields of the dead. As an exhibit the collection is one of the most attractive and, possibly, instructive now in the gallery.

It is announced that a decision taken at the concluding meeting of the International Congress of Orientalists at Athens in 1912 that the next meeting of the Congress should be held at Oxford is to be given effect. With the consent of the Vice-Chancellor of the University, the seventeenth International Congress will be held there during the week beginning Aug. 27, 1928. The approval of the Royal Asiatic Society has been obtained, and the leading oriental societies of France, Italy, Germany, Holland, and America have signified their intention to take part. The arrangements for the meeting are in the hands of the members of the Oriental Faculty of the University. It is to be hoped that the Congress will be strongly supported, for circumstances combine to give it a special importance. During the interval which has

elapsed since the last meeting the international bonds of common study have been strained and broken, while for Great Britain as an Empire with vital interests in the Middle and Farther East, the course of events since the War has given a peculiar significance to the subject-matter with which the Congress deals as one, and not the least important of the avenues by which we may arrive at an understanding of the mind of the various Eastern races. In the circumstances, no more appropriate meeting-place for the Congress than Oxford could be found. We trust, therefore, that the Oriental Faculty of the University may receive wide public support.

THE new laboratories of the Metropolitan Asylums Board at the Park Hospital, Hither Green, London, S.E., were opened on May 9 by Mr. Neville Chamberlain, Minister of Health. The buildings, which have cost about £13,500, have been equipped for research on the primary causation of infectious diseases and particularly acute fevers. Mr. Chamberlain, in his address, said that about 5 per cent. of the children born in London die from infectious disease before reaching twenty years of age. Apart from the suffering, this constitutes a great waste of human material, and Mr. Chamberlain expressed surprise that local authorities throughout Great Britain, which have to meet expenditure for isolation hospitals and treatment of infectious disease, have not done more in the past to discover the causes and means of prevention of such diseases. The results already achieved by the investigation of scarlet fever and diphtheria have been most encouraging and have shown that money spent on research in this field is a good investment.

ON Tuesday, April 26, a numerous party of members of the Illuminating Engineering Society and friends paid a visit to the National Physical Laboratory, Teddington, and were afforded an opportunity of inspecting the Photometric Section under the supervision of Mr. J. W. T. Walsh. Some of the most interesting features of the work were summarised by Mr. H. Buckley, who pointed out how it has become interlinked with that of other bodies, such as the Illuminating Engineering Society, and directed attention to the variety of researches being conducted for Government departments. In addition to the important work dealing with the unit of light, such problems as the design of picture galleries, the requirements for ships' navigating lights, the effects of glare, the relation between illumination and the carrying out of fine work, and reflection of artificial light from road surfaces have been studied. The visitors were afforded an opportunity of seeing the apparatus for such tests in operation, and much interest was taken in the equipment, notably the new 10-ft. diameter integrating sphere now installed. It was recalled in the discussion that the problem of devising a primary standard of light was raised in a comprehensive paper on photometry read by Prof. J. A. Fleming nearly twenty-five years ago. Research on this difficult problem is still proceeding at the National Physical Laboratory and elsewhere.

THE annual cider-tasting day took place at the University of Bristol Research Station, Long Ashton, on Thursday, May 5. The gathering was a record one, about 1000 visitors—mainly fruit growers, cider makers, and agriculturists—being present on the occasion. In addition to the usual display of single variety ciders made during the past season from the 1926 crop, there were exhibited ciders made from apples submitted by farmers of the surrounding counties in connexion with the Institute's scheme of cider-apple competitions. These competitions are designed to demonstrate to farmers the cider-making values of the various varieties grown in the different localities and to stimulate interest in the growing of high-grade cider fruit to meet the greatly increased requirements of the cider industry. The competitions are extremely popular with the farmer, and have proved of definite value to the Station for research purposes. During the day, parties of visitors were conducted around the laboratories and field plots by members of the Station staff, who demonstrated the practical results of the Institute's research work on problems of fruit culture. Special parties of fruit growers were organised for demonstrations of the results of research work on strawberries and for practical demonstrations in the making of spray fluids. Demonstrations of the use of various new models of motor-driven cultivators suitable for use in fruit plantations and of the latest types of spraying machines for applying spray fluids and 'dusts' were given by commercial firms throughout the day.

DR. L. PRANDTL, professor of applied mechanics in the University of Göttingen, has been awarded the Gold Medal of the Royal Aeronautical Society, in recognition of his work on aerodynamics. The medal will be presented on May 16, when Dr. Prandtl will deliver the fifteenth Wilbur Wright memorial lecture.

It will be remembered that a fund was subscribed by friends and old students of Dr. J. A. Fleming for a portrait to be presented to University College, London, in commemoration of his forty-two years' tenure of the chair of electrical engineering in the College. The portrait, which was painted by Sir William Orpen, is considered to be an excellent likeness, and is being exhibited in Room XI. at the Royal Academy.

MR. T. H. SAVORY, Biological Laboratory, Malvern College, Worcs., informs us that he is at present engaged in the compilation, for the Welsh National Museum, of a list of the spiders of Wales, to accompany a type collection which has recently been presented to the Museum. Records are not numerous, and it is desirable to be complete, if possible. Mr. Savory would therefore be glad to know of any work on Welsh spiders which has not been published or is not generally accessible.

INFORMATION has been received of further discoveries bearing upon the early peoples of East Africa by Mr. L. S. Leakey of the East Africa Stone Age Expedition. Portions of thirty-six skeletons have now been unearthed, of which twenty-six were found

in the Elmenteita district. According to a dispatch in the *Times* of May 4, Mr. Leakey considers the Elmenteita type to be even more primitive than that discovered at Nakuru in December last. In particular the nose is narrower, some individuals having a nasal index of 44. As a race they were tall, and differ markedly from the existing peoples of Kenya.

THE council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1926-27: Telford Gold Medals to Mr. I. J. Jones (London) and Mr. T. B. Hunter (London); a Watt Gold Medal to Mr. Gerald Curry (London); and a George Stephenson Gold Medal to Mr. A. L. Bell (Malta); Telford Premiums to Mr. A. W. Stonebridge (Bombay), Mr. P. R. Roberts (Barrow-in-Furness), Mr. A. C. Anderson (London), and Mr. George Ellison (London); a Manby Premium to Prof. Douglas Hay (Sheffield); and a Trevithick Premium to Mr. Powys Davies (India).

THE Paris correspondent of the *Times* announces that Baron Edmond de Rothschild, who has already done great service to scientific research in France by creating the Rothschild Foundation, has made another gift of 30,000,000 francs to the foundation for the purpose of endowing an institute for physical and chemical research as applied to biology. The work of the institute is to be conducted by a committee consisting of Profs. Jean Perrin, Job, and André of Paris, and M. Pierre Girard.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior assistant hydrographic surveyor under the Port of London Authority—The Staff Manager, Port of London Authority, Trinity Square, E.C.3 (May 18). A lecturer in pharmacology and therapeutics at St.

Bartholomew's Medical College—The Dean of the College, St. Bartholomew's Hospital, E.C.1 (May 20). A junior scientific assistant for Admiralty Research—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (May 21). A full-time lecturer in chemistry at the Polytechnic, Regent Street—The Director of Education, The Polytechnic, 309 Regent Street, W.1 (May 23). A full-time teacher of geography at the City of London College—The Secretary, City of London College, White Street, E.C.2 (May 27). An assistant lecturer in physiology in the University of Birmingham—The Secretary of the University (June 1). A professor of zoology at King's College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (June 2). A part-time research organiser under the Research Fund Committee of the Institute of Brewing—The Secretary, The Institute of Brewing, Brewers' Hall, Addle Street, E.C.2 (June 3). A full-time lecturer in electrical engineering at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. An assistant master for electrical engineering at the Rugby Technical School—P. I. Kitchen, 61 Clifton Road, Rugby. A graduate to teach botany at the Erith Technical College—The Principal, Technical College, Erith Road, Belvedere. A full-time mistress for mathematics and science at the Girls' Trade School of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. A part-time mistress for hygiene, physiology, health, and science subjects at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1.

ERRATA.—In NATURE of April 30, p. 629, col. 1, line 29, for "Haustein" read "Hanstein," and line 47, for "Son'ges" read "Souèges."

Our Astronomical Column.

GLOBULAR CLUSTERS AND SPIRAL NEBULÆ.—An article by Mr. A. R. Hinks in the *Nineteenth Century* for May gives a vivid account of the great enlargement of our conception of the size of the visible cosmos that has resulted from the work of Hale, Shapley, and Hubble at the great American observatories. The various stages in the deduction of the absolute magnitudes of the Cepheids are lucidly described; but one point in the proof, the practically perfect transparency of the celestial spaces, seems to need fuller treatment than is given in the article. The shortest proof appears to be the simultaneity of phase in light of different colours, whereas their speeds would be different in an absorbing medium.

Mr. Hinks was the first to detect the asymmetrical arrangement of the globular clusters: they lie in one hemisphere of the sky, with its pole in the galaxy. Further, their number is limited to about ninety, and no increase in optical power seems to add to it, so that they belong to a rather special class of objects, the curious grouping of which is still unexplained and merits further study.

Brief allusion is made in the article to Prof. Hubble's recent paper in the *Astrophysical Journal*, in which he assigns a distance of 140,000,000 light years to the smallest visible spiral nebulae. Representing the distance of α Centauri as one inch, these objects would be 550 miles away. Some verses by G. M. Minchin appeared in NATURE, April 14, 1898, p. 564. One verse ran:

"For, the rays that reach me here
May have left your photosphere
Ere the fight of Waterloo—
Ere the pterodactyl flew!"

The last line was probably intended as a bold exaggeration, but Hubble's result would make it literally true.

ASTROPHYSICS IN RUSSIA.—The State Astrophysical Institute of Russia is publishing *Trudy* (Memoirs), the first volume of which appeared in 1922, the second in 1923, and two parts of the current third volume in 1925 and 1926, respectively. The contents of the published volumes are very varied, both theoretical papers and those elucidating various practical points of astrophysics being well represented. To the former category belong papers by V. A. Kostizyn on masses of stars and on equilibrium of radiation in stars; those by V. G. Fesenkov on the evolution of the solar system, on cosmic refraction, on the structure of the atmosphere from photometric observations, and others. Some of the practical papers deal with the technique of stellar photography in particular cases; B. V. Numerov describes a new method of determination of orbits and of calculation of ephemerids; E. K. Epik writes on photometric properties of air and of clouds (with an explanation of variations in the brightness of Venus). The latest volume contains a catalogue of equatorial components of velocities of 1470 stars.

Research Items.

PRE-COLUMBIAN HUASTEC MOUNDS IN THE TAMPICO REGION, MEXICO.—Municipal and other work carried out at various times in the Tampico district of Mexico, which has necessitated the demolition of a number of the many mounds in the area belonging to the Huastec civilisation, has at the same time made it possible to form an accurate idea of their composition and structure. A number of observations of a series of mounds on one of the haciendas and on a series on the Colonia Flores on the north-western environs of Tampico are recorded in a paper contributed to the *Journal of the Royal Anthropological Institute*, vol. 56, pt. 2, by Mr. John M. Muir, who has been assisted in the mapping of the mounds by Mr. Cecil Drake. The mounds were used as the foundations for buildings, and were clearly raised or reconstructed from time to time, a cement floor being laid on each occasion. Sometimes as many as five floors were found in one mound. Steps were built for easy ascent to the floor of occupation, which in all likelihood was covered by a wooden structure. Any material conveniently available was used—shells, stone slabs, and even asphalt. Where no other material was available, soil was used. Oyster shells from pleistocene deposits were abundant on the Colonia Flores site, and were also used to form the cement floors. In one of the mounds a painted design was found which had been executed in a reddish colour and then apparently coated over in black. The drawing is 270 cm. long and 135 cm. wide and is approximately rectangular, resembling a ground plan in appearance. On the cement floor underlying this was found another painted design similar in character but more elaborate and complete. No purpose can at present be suggested for these

and 'galley' proofs, but what remained of Section 6, dealing with "Special Estuarine Fishes," which was in manuscript and rescued from a damp outhouse, has been so far as possible transcribed. Part 2 as it now exists is a folio volume of 256 pages, and in addition there is a number of drawings intended to illustrate it. The work is exceedingly valuable, embracing notes by an experienced authority on a large range of problems relating to the fisheries industries, much of which is new, and the whole brought together in a useful form. The part in question includes sections on whales, crustacea, shellfish, fishing grounds, nets, etc., plaice, spratting, whitebaiting, smelting, eel-spearling and trawling, spruling, shrimp trawling and shrimping, crab and lobster fishing, prawning, oyster industry, clam digging, scallop dredging, whelk trotting and potting, starfish, white weed gathering, and dredging. There are also sections on the Leigh fishermen, the fishing craft, apparatus for capture, cooking, transport, etc., fish products and economics of the fisheries. It would be a great pity if this work were lost, and it is apparently a question of funds as to whether it should be published. It is at present available for reference at the Library of the County Borough of Southend-on-Sea, and students interested in the subjects are invited to consult it.

CHROMOSOMES OF DIOECIOUS PLANTS.—From a study of root-tips in *Vallisneria spiralis* and *V. gigantea*, Mr. C. A. Jorgensen (*Jour. Genetics*, vol. 18, No. 1) finds 20 chromosomes in the former (3 long pairs, 2 intermediate pairs, and 5 short pairs), while the latter species is tetraploid, having twice as many of each type of chromosome. Moreover, in these dioecious species the chromosome number and morphology appear to be the same in male as in female plants. These studies are confirmed by examination of the nuclear division in the pollen grains, in which the corresponding haploid numbers are found. Loss of chromosomes and probable non-disjunction is also found in the pollen meiosis, which accounts for the numbers observed by Winge, who mistook these conditions as indicating the presence of an XO set of sex chromosomes. Winge confirms this in the same issue of the *Journal of Genetics*, a lagging chromosome which he mistook for the X-chromosome being occasionally left behind and two chromosomes sometimes becoming attached to each other. Similarly in *Najas marina*, another dioecious plant, he finds no sex chromosomes, but in somatic cells sometimes 12, sometimes 14 chromosomes, owing to the smallest two pairs being more or less united. In the reduction division, six gemini are accordingly found, but Guignard occasionally found seven.

EYE-STRAIN IN THE HOSIERY INDUSTRY.—No. 40 of the Reports of the Industrial Fatigue Research Board, by H. C. Weston and S. Adams (London: H.M. Stationery Office, 1927. 1s. net), deals with the effect of eye-strain on the output of linkers in the hosiery industry. The output of three operatives was recorded for a period of four weeks in order to determine the normal rate of working under existing conditions. The operatives were then examined and fitted with glasses suitable for the nature of the work, which involved a high degree of accommodation and convergence of the eyes. The output was then measured as before. The data show that the use of the glasses had important results. In the first place, the general rate of output was increased; and secondly, the usual fall of the output at the end of the day was considerably reduced. The subjects themselves experienced great relief as a result of wearing the glasses; their eyes did not feel so tired either during the working day or when they returned home at night. The writers suggest that it might be an advantage in other operations which make heavy demands on the eyes to wear suitable glasses. They point out, though, that it will always be necessary to examine and prescribe for each subject individually.

FISHING INDUSTRIES OF THE THAMES ESTUARY.—Reference was made last year (*NATURE*, June 19, 1926, p. 870) to a printed portion of Part 2 of the late Dr. Murie's "Report on the Sea Fisheries and Fishing Industries of the Thames Estuary," Part 1 of which was published in 1903. We are now advised by Mr. W. Pollitt, Borough Librarian and Curator of the Public Libraries and Museum, Southend-on-Sea, that a large portion of the remainder of Part 2 has been recovered. This consists chiefly of working proofs

THE SERPENTINE BELT OF BURMA.—The *Journal of the Burma Research Society*, 16, p. 176, 1927, contains an interesting account of the serpentines of Burma by H. L. Chhibber. The intrusions described occur in the Henzada and Bassein districts, and consist of wholly or partly altered saxonites, lherzolites, and dunites. Hornblende-eclogite is also described. As usual, chromite occurs in segregated patches, but communications are still too bad to encourage the commercial exploitation of this mineral. The intrusions form part of a long interrupted belt of similar rocks that extend from the Andamans through the Arakan Yomas and the Chin Hills to the northern frontier of Burma. In Burma the belt is roughly parallel to the Irrawaddy-Chindwin valley and to the central volcanic line of the country. The author considers the age of the intrusions to range from late Cretaceous to early Eocene. Nummulitic

sandstones referred to the Laki stage contain derived fragments of serpentine, and are themselves invaded by later ultrabasic rocks.

THE GLACIAL ORIGIN OF DRUMLINS.—In the *Geological Magazine* for April, Prof. J. K. Charlesworth marshals a convincing array of evidence against Prof. J. W. Gregory's recent advocacy of the view that drumlins have been carved out of boulder-clay by the post-glacial action of wind and rain. Drumlins are commonly elongated parallel to the last direction of ice-flow, though they may lie oblique to the striæ directions scored in a pavement rock during earlier stages. One end is usually narrow and tapering, the other broader and steeper, and the blunt end faces the direction of ice advance. This feature suggests moulding by a moving ice-sheet. Drumlins are sometimes found beneath the moraines and eskers accumulated during the last recessional phase; they may be scarped by late-glacial lakes and by the 25-ft., 50-ft., and 100-ft. seas demonstrated by the raised beaches of Scotland; and in the lake deposits occasionally found in the hollows between drumlins, remains of the Irish elk have been discovered. There is thus incontrovertible proof that the period of drumlin formation preceded the close of the Quaternary ice age. Moreover, on the post-glacial theory, drumlins should not be restricted in distribution to boulder-clay regions. Prof. Charlesworth points out, however, that although the post-glacial hypothesis is manifestly inadequate, the glacial-moulding hypothesis has not yet been convincingly developed from the physical point of view. The physics of ice flow is still too little understood for a final solution of the problem.

DEFLEXION OF ATOMIC RAYS.—Magnetic deflexion of atomic rays is a relatively new line of research, and Prof. O. Stern's critical discussion of the method in No. 8 of the last volume of the *Zeitschrift für Physik* comes very opportunely. Since it is necessary to measure a deflexion of the pencil of rays through a distance not very much greater than the width of the limiting slits, the intensity distribution in the final trace is evidently of importance, and Prof. Stern has shown that in one instance neglect of this has introduced an unrecognised error of not less than 20 per cent. The greatest uncertainty at present, however, is in the measurement of the intense inhomogeneous magnetic fields which have to be employed, where the accuracy has been limited by knowledge of the susceptibility of bismuth. If, as appears probable, the method now in use could be bettered, Prof. Stern believes that experiments with molecular rays would give at least as precise a value for e/m as those based on observation of the Zeeman effect. The paper is accompanied by an account of work done in Prof. Stern's laboratory on the magnetic moments of the atoms of thallium, potassium, and sodium, by Dr. Leu, and the moment of hydrogen, by Dr. Wrede; both authors have made refinements in the technique. To within a few per cent., potassium, sodium, and hydrogen all have a moment of one Bohr magneton, and thallium one-third of a magneton.

DENSITY OF BORON TRICHLORIDE.—The accurate determination of densities of liquids by means of glass floats has recently been applied by Robinson and Smith to the problem of the constancy of the atomic weight of silicon from different sources. In the February issue of the *Journal of the Chemical Society*, Briscoe, Robinson, and Smith have published the results of a similar investigation on the densities of different samples of boron trichloride. The

approximate density of the trichloride ($D. 1.350/11^\circ$) was determined by means of a glass hydrometer, and suitable floats were constructed and calibrated in *n*-propyl bromide ($D. 1.364/18^\circ$). The densities of boron trichloride, prepared from boron obtained from California, Tuscany, and Asia Minor, were measured, and the relative atomic weights of the samples calculated. The results confirm the discrepancies between the atomic weights of boron from the three sources, which were first noticed in the ratios $\text{BCl}_3 : 3\text{Ag}$, and in the densities of the fused boron trioxide.

CELLULOSE PAINTS.—We have received from the Institution of Automobile Engineers a copy of a paper by W. F. Starkey on nitro-cellulose enamels. In view of the increasing importance of this type of varnishing medium, especially in the motor-car industry, the information which the paper contains is of great interest. A typical nitro-cellulose paint contains nitro-cellulose of suitable solubility and viscosity, solid or liquid plasticisers to impart flow to the material, and a gum resin which will give gloss to the finished product without detracting from the surface hardness, dissolved in a solvent with as high a degree of volatility as is commensurate with the avoidance of chilling and with ease of application. The enamel is applied by the use of a spray pistol, after the surface to be treated has been thoroughly cleaned. It dries in half an hour, is harder than ordinary enamel, resists acids, alkalies, petrol, and heat, and although it has less gloss than ordinary enamel, this improves with cleaning and rubbing. The plasticisers and softeners used in the preparation of cellulose lacquers and paints are discussed by T. H. Durrans in the *Chemical Trade Journal* for Mar. 11. Plasticisers are required to impart a degree of elasticity to the film, as a rapidly drying paint is very brittle. The properties of sixteen organic substances of high boiling-point which are used as softeners and plasticisers are discussed in this article. The best cellulose enamels contain medium boiling-point solvents and high boiling-point plasticisers.

WALLIS'S AXIOM OF PARALLELS.—It is well known that Euclid's axiom of parallels is independent of the other assumptions made by him, and that several axioms have been suggested in place of that given by Euclid. Among these is Wallis's axiom that "to every figure there exists a similar figure of arbitrary magnitude." Prof. M. J. M. Hill, in his presidential address to the Mathematical Association (*Math. Gazette*, March 1927), has simplified Wallis's axiom to the following: Given any triangle, then a triangle with angles congruent to the corresponding angles of the given triangle can be constructed on any given base, and on a given side of the base. Assuming then some axioms on the congruence of angles, but without assuming anything on the congruence of intervals or of triangles, and without making any appeal to continuity, he shows that his axiom leads to the Euclidean parallel axiom both in the form given by Euclid and in Playfair's form, and that the further axiom that all right angles are congruent can also be shown from the same basis. This part of geometric theory thus involves the congruence of angles only and can be treated independently of the rest of geometry. Of the other substitutes for Euclid's axiom, besides Playfair's form, the best known is that which asserts that the sum of the angles of a triangle equals two right angles. But to deduce the Euclidean axiom from this, the full theory of the congruence of triangles is needed, and furthermore, as Dehn has proved, the axiom of Archimedes has to be assumed. The Wallis-Hill axiom thus supplies a much simpler basis for this part of geometry.

The Himalayan Silver Fir and Aeroplane Construction.

AN important communication (*Indian Forest Research Institute Bulletin*, No. 69 Economy Series, 1926) has been recently issued from the Research Institute at Dehra Dun, India, dealing with "The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir." The work of the various branches of the Research Institute is laid down on a triennial basis, lines of investigation to be undertaken being entitled "Projects." The present bulletin refers to timber-testing work under Projects Nos. I. and II. on *Picea Morinda* and *Abies Pindrow*.

These two species have been but sparsely utilised by the markets up to date owing to costs of extraction and a lack of knowledge as to the properties of the timbers. They exist in large quantities in northern India. Spruce is found in the Himalayan tracts from Afghanistan to Kumaon, from 7000 ft. to 11,000 ft. elevation, and commonly mixed with fir, deodar, and *Pinus excelsa*. The silver fir extends from Afghanistan to Nepal, from 7500 ft. to 11,000 ft., sometimes as pure crops but commonly mixed with spruce, deodar, and *Pinus excelsa*, and at times associated with broad-leaved species. It is estimated that existing mixed spruce and silver fir forest could supply a sustained annual yield of more than two million cubic feet, the best localities being enumerated. Both species grow to a large size. Himalayan spruce are reported up to 215 ft. in height and as much as 23 ft. in girth, whilst the Himalayan silver fir has reached a size of 202 ft. in height and 26 ft. in girth.

The investigations carried out in the timber-testing branch of the Institute were undertaken in order to ascertain the strengths of the two timbers for constructional, aeroplane, and other purposes. Incidentally, the question as to whether the spruce red wood was inferior to spruce white wood was decided. The impression that such is the case is commonly held. The investigations showed, however, that the red wood, which is simply the darker, denser material near the centre of the lower portion of the tree-trunk, is in no way inferior to spruce white wood when taken

from healthy living trees. The tests have demonstrated that the timber of silver fir has proved to be stronger than the spruce, which is also the case, in some parts, with the European species of these genera. Apart from its scientific aspects, the bulletin has both a commercial and Empire value owing to the deductions derivable from the tests.

The two principal causes which have led to complaints, both from the match manufacturer and others, and to the restricted use of these two conifers in India, are the prevalence of knots and the lack of durability of these timbers. The comparison has usually been made with some of India's most valuable timbers, such as deodar, teak, *Xylia dolabriformis*, and so forth. A similar comparison in Europe would be to contrast silver fir and spruce with oak. The tests have shown that the Himalayan spruce and silver fir are at least as durable as and stronger than the corresponding species of Europe and America. The investigations carried out were made on similar lines and are strictly comparable with the results obtained in the Forest Products Laboratories both in Canada and the United States. The Himalayan silver fir has been proved to be stronger than Sitka spruce (*Picea sitchensis*), the accepted conifer for use in aeroplane construction. It is held that the Himalayan species are not more knotty than the spruces and firs of other parts of the world, with the exception of the Sitka spruce. The tests have shown that the silver fir is less knotty than the spruce in the Himalaya, and a case appears to have been made out for a careful survey of the denser older forests of the former species with the view of the possibility of their being able to furnish aeroplane material.

It is a common British failing to suppose that the foreigner has a better article than can be obtained in the Empire, so this careful piece of research work deserves to be widely known. For the time is assuredly approaching when the silver fir and spruce belt of the western Himalaya will furnish its quota to assist the rapidly dwindling soft-wood supplies of the globe.

The Influence of Impurities on Copper.

THE work that Prof. D. Hanson and his co-workers have been carrying out on the effect of various impurities on copper of the highest degree of purity is extended in two papers read recently before the Institute of Metals. The first of these, in collaboration with Miss G. W. Ford, deals with the influence of bismuth, the solubility of which in solid copper is less than 0.002 per cent. Small amounts of this element adversely affect the rolling properties of copper, particularly during hot-rolling, and the limiting percentage for this process appears to be less than 0.01 per cent. In cold-rolling, the material fractured when more than about 0.05 per cent. of bismuth was present. Even with smaller amounts the effect is bad, especially where the degree of cold-work is great. The effects of this impurity on the electrical conductivity and tensile strength are small.

The second paper, carried out in collaboration with C. B. Marryat, deals with the influence of arsenic, alone and together with oxygen. Copper containing up to 1 per cent. of arsenic alone is very difficult to produce as completely sound castings, but the presence of a little oxygen greatly improves the casting properties. The copper-arsenic alloys are, however, exceedingly ductile and can be worked, both hot and cold, to almost any desired extent. Arsenic alone has but a small hardening effect on pure copper, the

Brinell hardness of which, in the annealed state, is almost constant, nor is the ductility greatly affected. In the case of cold-worked metal the arsenic does definitely increase the hardness. The ratio of the fatigue range to the tensile strength of arsenical copper is relatively high, about 0.9; higher, that is, than in copper containing oxygen or iron. The effect of the element on the electrical conductivity is profound, being much greater than that of either of the two latter metals. It reduces the size of the crystals in the castings, but has no appreciable effect on the structure of worked and annealed copper. The solubility of arsenic in solid copper is about 7.25 per cent., a figure which alters little with temperature.

The simultaneous presence of arsenic and oxygen leads to the following effects. The presence of arsenic reduces the deleterious effects of oxygen on the cold-working properties of copper. As the ratio of arsenic to oxygen is raised the cast bars become more ductile, but, unless this ratio is high, the metal is in an over-rolled condition and for severe cold-work the arsenic must exceed ten times the content of oxygen, and a much higher ratio than this is still quite satisfactory. The necessary ratio of these two impurities depends on the amount of cold-work to be done; the greater the amount of cold-working, the greater is the amount of arsenic required. Hot rolling of the copper con-

taining both elements can be done without difficulty.

The mechanical tests differ little from those given by arsenic without oxygen, and the same applies to the electrical resistivity. The oxygen, which occurs in pure copper as cuprous oxide, combines, when more than 1 per cent. of arsenic is present, to form a slaty-grey compound which is a reaction product of cuprous oxide and arsenic. The softening temperature of copper is raised by arsenic whether oxygen is present or not. Arsenic is without effect on the tendency of copper to become brittle through heating in hydrogen.

F. C. T.

University and Educational Intelligence.

BRISTOL.—Four scholarships are offered by the Society of Merchant Venturers to matriculated candidates of not less than 17 years of age. The scholarships provide free tuition; one is open to pupils in any secondary school; three are restricted to pupils of secondary schools situated in the counties of Gloucestershire, Somerset, and Wiltshire. A War Memorial scholarship is also offered, with a preference to a candidate needing pecuniary help who is the son of a former student who lost his life while serving with H.M. Forces during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College.

CAMBRIDGE.—Mr. H. E. Tunnicliffe, Gonville and Caius College, has been appointed University demonstrator in physiology.

OXFORD.—The Halley Lecture for 1927 will be delivered on Friday, May 20, at 5 P.M., in the University Museum, by Lieut.-Colonel F. J. M. Stratton, of Gonville and Caius College, Cambridge, on the subject of "Modern Eclipse Problems."

DR. WILLIAM THOMAS, lecturer in chemistry in the University of Aberdeen, has been appointed principal of the Denbighshire Technical Institute, Wrexham, North Wales.

PROF. H. H. TURNER, Savilian professor of astronomy in the University of Oxford, will deliver a lecture at Birkbeck College, London, on May 25, on "The Total Eclipse of the Sun." The lecture is one of the special lectures arranged for teachers by the London County Council.

COURSES of free public lectures have been arranged by the Armourers and Brasiers' Company as follows: "Special Steels and their application in Engineering," by Dr. W. H. Hatfield (at the Sir John Cass Technical Institute, on May 17 and 31 and June 14, at 6.30), and "Oxidation, Corrosion, and Passivity of Metals," by Mr. U. R. Evans (at the Royal School of Mines, on May 18 and 25 and June 1, at 5.30). No tickets will be necessary. The Armourers and Brasiers' Company has founded senior industrial bursaries of £170 per annum and junior industrial bursaries of £50 per annum, the former to assist young men who have obtained honours at the final examination at the University of London for the degree of B.Sc. (Eng.), (mining) or (metallurgy), to enable them to prosecute further studies, and the latter to enable youths who have shown promise in their preliminary studies in subjects relating to engineering or metallurgy to continue those studies.

Calendar of Discovery and Invention.

May 16, 1888.—Whereas in the phonograph Edison made his sound records by causing the engraving tool to rise and fall, Emile Berliner in his gramophone employed a tool moving from side to side in a spiral groove cut in a disc. Berliner's original gramophone was first publicly exhibited in the Franklin Institute, on May 16, 1888, and it is now in the National Museum, Washington, D.C.

May 17, 1823.—Jacob Perkins was one of the pioneers of the use of high-pressure steam in engines, and he was also the first to put into practice heating by steam, the British patent for which is dated May 17, 1823.

May 18, 1825.—In the minutes of the Royal Society of Arts for May 18, 1825, is a report on Sturgeon's apparatus for exhibiting the principles of electro-magnetism. It was then resolved to award Sturgeon the Silver Medal and thirty guineas on condition of his leaving a complete apparatus and description thereof with the Society for the use of the public and relinquishing all pretensions to a patent. Included in this apparatus was the first electro-magnet, a horse shoe of soft iron made from a round bar about $\frac{1}{2}$ in. in diameter wound over with about eighteen turns of copper wire. Though this historic gift has been lost, the transactions of the Society contain an illustration of it, and by means of this Prof. Fleming had a replica made which he presented to the Science Museum, South Kensington.

May 19, 1766.—When Euler left Berlin for St. Petersburg, D'Alembert suggested to Frederick the Great that his place in the Academy of Sciences should be filled by Lagrange. To this Frederick agreed, and on May 19, 1766, D'Alembert wrote to the King, "Je me tiens trop heureux d'avoir pu réussir dans cette négociation, et procurer à Votre Majesté et à son Académie, un si excellent sujet. Cet événement répand dans mon âme une satisfaction dont je n'ai pas joui depuis longtemps, et je suis sûr que mon estomac s'en ressentira."

May 19, 1919.—The first to attempt the direct flight from America to Europe for the £10,000 prize offered by Lord Northcliffe were Hawker and Grieve, who on May 19, 1919, set out from St. Johns, Newfoundland, in a Sopwith biplane driven by a Rolls-Royce engine. They had flown about 1100 miles in 14½ hours when the cooling water arrangements of the engine failed. It being impossible to complete the journey, search was made for a ship and the aeroplane brought down in the water close to her, both pilots being rescued and brought to England.

May 20, 1859.—Through information regarding the work of James Young on the distillation of oil, efforts were made to bore for oil in the United States. The first, however, to sink such a well, and thus become the founder of the great petroleum industry of America, was Colonel Drake, who on May 20, 1859, with four companions, began drilling in the woods of Pennsylvania, and after three months' strenuous work obtained oil from the rock on Aug. 27, 1859, for the first time.

May 21, 1797.—"Wherever the steam-mill resounds with the hum of industry, whether grinding flour on his native Schuylkill or cutting logs in Oregon, there do you find a monument to the memory of Oliver Evans." This tribute recalls the inventor who worked out the modern system of flour milling and was one of the first to use high-pressure steam. Among his patents was that of May 21, 1797, for a steam-driven carriage. He afterwards made a crude steam-driven vehicle and also a steam dredger.

E. C. S.

Societies and Academies.

LONDON.

Royal Statistical Society, April 26.—Miss E. M. Newbold: The practical application of the statistics of repeated events with special reference to the personal factor in industrial accidents. The Industrial Fatigue Research Board has in progress an inquiry into individual liability to accident, and the possibility of sorting out persons who ought not to be placed in particularly dangerous occupations. Records of minor accidents among various groups of factory workers, dockyard apprentices, and Royal Air Force apprentices have been compared with the results obtained with selected psychological tests. The statistical side of this investigation, and the effect of chance variation on figures of this kind, were discussed. As regards these minor accidents, the average rate is considerably affected by a comparatively small proportion of people with repeated accidents, whose liability shows measurable stability when they are observed over successive periods and also in different circumstances. These same people also report sick for various minor ailments more frequently than their fellow-workers.

PARIS.

Academy of Sciences, April 4.—Marcel Brillouin: Oceans and continents. Oceanic tides and soil tides. Normalised formulae for their theoretical calculation.—C. Matignon and M. Piettre: The preparation of beryllium chloride. Beryllia, heated to between 700° and 800° C. in a pyrex glass tube and submitted to a current of chlorine carrying the vapour of sulphur chloride, is readily converted into beryllium chloride, which volatilises. Sulphur chloride may be replaced by the vapour of carbon tetrachloride or by phosphorus trichloride, but in the latter case the product is contaminated with a little phosphorus trichloride.—de Sparre: Remarks on the note by M. Sugot, of Feb. 28, 1927, on the integration of the differential equations of the gyroscopic motion of a projectile.—Jean Baptiste Senderens: The catalytic decomposition of formic acid. Study of the rate of production of carbon monoxide by the action of sulphuric acid of various strengths and of other catalysts (anhydrous aluminium sulphate, potassium bisulphate, orthophosphoric acid) on formic acid.—Charles Nicolle, H. Sparrow, and E. Conseil: The preventive vaccination of man against exanthematous typhus by the use of small repeated virulent doses (brain of the guinea-pig).—E. Cartan: The geodesics of spaces of simple groups.—A. Gheorghiu: The growth of the denominator $D(\lambda)$ of Fredholm.—D. V. Jonesco: A problem relating to the theory of partial differential equations of the second order with real characteristics.—Albert Portevin and André Sourdillon: The influence of the tempering temperature on the deformations of steel cylinders.—Barbillion: The distribution of the Foucault currents in a metallic disc submitted to the action of an inductor pole of circular section, but eccentric with respect to the disc.—Iser Solomon: A direct reading and continuous radio-qualitometer. An instrument for measuring the quality of the X-rays when used therapeutically.—C. Mihul: The third order spectrum of oxygen.—R. Descamps: The rotatory dispersion in the ultra-violet of aqueous solutions of tartaric acid containing boric acid.—Georges Fournier: A relation between the atomic weights of isotopic radio-elements and the velocity of the α -rays which they emit. The velocity of the rays, v , is given by $v_0 - kA$, where v_0 is a term which varies from one group of isotopes to another, A is the atomic weight of the emitting radio-element,

and k is a constant. Polonium forms an exception.—René Audubert: The determination of the energies of reaction by a knowledge of the active light.—B. Bogitch: The reduction of the oxide minerals.—André Kling and Daniel Florentin: The transformation of the phenols into hydrocarbons in the presence of catalysts and hydrogen under pressure. All aromatic and cyclohexane hydroxyl derivatives heated in the presence of hydrogen under pressure (70 kgm. to 80 kgm. per sq. cm.) with a dehydrating catalyst such as alumina, clay, thoria, silica, give good yields of the saturated hydrocarbons. Thus ordinary phenol with 5 per cent. of alumina heated with hydrogen under pressure to 480° C. gives benzene with some fatty hydrocarbons. Ordinary commercial cresol under the same conditions gives 35 per cent. of light hydrocarbons.—Raymond Quelet: Parabromobenzyl chloride and the Grignard reaction. The reaction between $\text{BrC}_6\text{H}_4\text{CH}_2\text{Cl}$ and magnesium gives parabromotoluene and *p.p.*'-dibromodiphenylethane.—Maurice Nicloux: The microestimation of carbon. Applications. The method is limited to those compounds which can be completely burnt by heating with sulphuric acid, potassium bichromate, and silver bichromate in solution. Test analyses of various organic substances are given, the quantities taken for analysis being 4 mgm.-16 mgm.—Paul Corbin and Nicolas Oulianoff: The *besimaudites* of Prarion (Haute-Savoie).—Mlle. Rémy: Experimental mutations and the mechanisms of spontaneous mutations.—G. Nadson: The perforating algae of the Black Sea. The perforating algae are very widely distributed in the Black Sea and play an important part in the destruction of the limestone coast, oyster beds, and generally all calcareous substances.—G. Guittonneau and J. Keilling: Rendering elementary sulphur soluble and the formation of hyposulphites in a soil rich in organic nitrogen.—Emile André: Relations between the development of the liver and that of the sexual glands in some cartilaginous fishes.—A. Gurwitsch and G. Franck: The mitogenetic rays and their identity with ultra-violet rays.—Joseph Magrou and Mme. Madeleine Magrou: Mitogenetic radiations and the genesis of tumours.—Georges Lakhovsky: The influence of the astral radiations on the oscillation of living cells.—Henri Mémery: The influence of the astral radiations on wines.—Swigel and Théodore Posternak: The preparation of polypeptides containing the phosphorus and ferric nuclei of ovovitel-line.—A. C. Marie and S. Mutermilch: Attempts at antirabic vaccination of the rabbit in the meningeal cavity.

WASHINGTON, D.C.

National Academy of Science (*Proc.*, Vol. 13, No. 2, February).—Norbert Wiener: On the closure of certain assemblages of trigonometrical functions.—G. Y. Rainich: On a type of Lorentz transformations.—Gordon T. Whyburn: Cyclicly connected continuous curves.—L. P. Eisenhart and M. S. Knebelman: Displacements in a geometry of paths which carry paths into paths.—Edwin H. Hall: Photo-electric emission, thermionic emission, and Peltier effect (from the point of view of dual electric conduction). These effects can be accounted for on the assumption that the greater part of the current within a metal is carried by electrons travelling from atom to atom without sharing the heat energy and a much smaller portion by 'free' electrons.—P. W. Bridgman: The transverse thermo-electric effect in metal crystals. With single crystal bars of bismuth about 10 cm. long and 6 mm. in diameter, basal plane inclined at 20° to the length, a temperature difference of 0.4° C. between two sides of the bar was observed when currents of 1 amp. were passed along it. Similar

but much smaller effects were obtained with zinc, tin, and cadmium. Kelvin's theoretical prediction of the effect is thus verified, but his reasoning seems inadequate. Regarding the current as an electron stream, the effect seems to be due to the reversible absorption or evolution of heat which occurs on the change of net direction of the electron stream with respect to a crystal axis inclined to the surface, after reflection from the surface.—Worth H. Rodebush: The effect of velocity distribution on the deflexion of atoms in an inhomogeneous magnetic field.—Carl Barus: Pinhole probe record of the closed organ pipe.—A. H. Warner: A comparison of the thermionic and photoelectric work functions for clean tungsten. The work functions in Richardson's thermionic equation and also in Einstein's photoelectric equation, which measure the work necessary to carry an electron from the interior of the metal to a position outside and beyond the influence of the image force, should, if conduction electrons are concerned in each process, be identical when measured at the same temperature. This has been verified within the limits of experimental error for clean tungsten illuminated by a quartz mercury arc and a monochromatic illuminator.—Enos E. Witmer: The quantisation of the rotational motion of the polyatomic molecule by the new wave mechanics. The polyatomic molecule is regarded as a rigid body with three principal moments of inertia.—Stanley Smith: A note on the spectrum of doubly ionised scandium.—Robert E. Burk: The thermal decomposition of ammonia upon the surface of a molybdenum wire. The effect of the initial pressure of ammonia upon the time of half life at 1228° Abs. suggests an apparent order of the reaction of zero. Hydrogen as an impurity was almost without effect; nitrogen caused marked retardation (catalyst poison), which persisted after pumping off to a vacuum. The results can be explained equally well by assuming that the reaction continues on parts of the surface not poisoned or that it can take place, at a reduced rate, on the poisoning film of nitrogen. Working at 1097°-1228° Abs., measurements of the temperature coefficient indicate a true heat of activation of 53,200 cal.—A. V. Kidder: Eskimos and plants. Fernald supposes that the highly specialised plants found in the Arctic Archipelago, the Torngat Mountains of Labrador, and similar localities in Northern America, are remnants of a general preglacial flora surviving in districts not covered by continental ice during the Pleistocene. It is suggested that the Eskimos are comparable in many ways with Fernald's plants.—C. Stuart Gager and A. F. Blakeslee: Chromosome and gene mutations in *Datura* following exposure to radium rays. Sealed glass tubes containing radium emanation were inserted into flower buds of *Datura Stramonium*. The results claimed include an increased percentage of chromosomal mutants, a new compound chromosomal type, Nubbin, and two new gene mutants.—A. F. Blakeslee: The chromosomal constitution of Nubbin, a compound ($2n+1$) type in *Datura*.

Official Publications Received.

BRITISH.

Department of the Interior, Canada. Natural Resources Intelligence Service. Canada as a National Property. Pp. 75+9 maps. (Ottawa: F. A. Acland.)

Society of Chemical Industry: Chemical Engineering Group. Proceedings. Vols. 6B and 7, 1924-1925. Pp. vii+109. (London.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1924. Pp. v+127. (London: H.M. Stationery Office.) 4s. 6d. net.

Annals of Eugenics: a Journal for the Scientific Study of Racial Problems. Edited by Karl Pearson, assisted by Ethel M. Elderton. Vol. 2, Parts 1 and 2, April. Pp. 244. (London: Francis Galton Laboratory for National Eugenics, University College.) 35s. net.

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Report of the Oversea Settlement Committee for the Year ended 31st December 1926 (Cmd. 2847.) Pp. 36. (London: H.M. Stationery Office.) 6d. net.

Mysore Geological Department. Records, Vol. 24, 1925. Part 2. Pp. v+2+164. (Bangalore: Government Press.) 2 rupees.

Bureau of Education, India. Occasional Reports, No. 14: Some Experiments in Indian Education. Pp. iv+54. (Calcutta: Government of India Central Publication Branch.) 1.8 rupees+2s. 6d.

British Guiana: Combined Court, Annual Session 1926. Interim Report and Statement of Policy of Geological Survey. By the Economic Geologist and Mineralogist. Pp. 8. (Georgetown, Demerara.)

Publications of the South African Institute for Medical Research. No. 19: Contributions to the Study of Miners' Phthisis. By A. Mavrogordato. Pp. 83+13 plates+13 graphs. (Johannesburg.) 5s.

Deep Level Mining and High Temperatures: an Enquiry into certain Cases of Sudden Death presumably due to Heat Stroke, with a Report on the Associated Conditions. By A. Mavrogordato and H. Pirow. (Reprinted from the *Journal of the South African Institution of Engineers*, Vol. 25.) Pp. 23. (Johannesburg: South African Institute for Medical Research.)

Cocoa: the Story of its Cultivation. Pp. 48. (Bournville: Cadbury Bros., Ltd.)

Seale-Hayne Agricultural College, Newton Abbot, Devon: Department of Plant Pathology. Third Annual Report for the Year ending September 30th, 1926 (Pamphlet No. 21.) Pp. 27. (Newton Abbot.)

The National Physical Laboratory. Watch and Chronometer Trials, 1926. Pp. 6. (London: H.M. Stationery Office.) 6d. net.

Journal of the Chemical Society: containing Papers communicated to the Society. April. Pp. vi+iv+667-900. (London: Gurney and Jackson.)

The Quarterly Journal of the Geological Society. Vol. 83, Part 1, No. 329, April 23rd. Pp. xlvii+194+12 plates. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

FOREIGN.

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1926. Pp. 41+4 plates. (New York City.)

Smithsonian Miscellaneous Collections. Vol. 75, No. 4: Cambrian Geology and Paleontology, V. No. 4: Pre-Devonian Sedimentation in Southern Canadian Rocky Mountains. By Charles D. Walcott. (Publication 2870.) Pp. 147-173. (Washington, D.C.: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 24: An Outline of Methods of Research, with Suggestions for High School Principals and Teachers. Pp. vi+31. (Washington, D.C.: Government Printing Office.) 10 cents.

Travaux et Mémoires du Bureau International des Poids et Mesures. Publiés sous les auspices du Comité International par le Directeur du Bureau. Tome 17. Pp. vi+240+142+95+4. (Paris: Gauthier-Villars et Cie.)

Ministry of Finance: Control of Printing. Almanac for the Year 1927. Pp. ix+358. (Cairo: Government Publications Office.) 7 P.T.

Travaux de la Section de Géodésie de l'Union Géodésique et Géophysique Internationale. Tome 3: Rapports nationaux sur les travaux exécutés dans les différents pays pendant la deuxième assemblée générale, Madrid, 24 septembre—3 octobre 1924. 19 rapports. (Paris.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 16, Part 5: Beiträge zur Entwicklungsgeschichte der Reptilien. I: Die frühesten Entwicklungsvorgänge bei der Waldeidechse (*Lacerta vivipara* Jacq.). Von Tetsuo Inukai. Pp. 125-201+14 Tafeln. Vol. 16, Part 6: Studies on the Sauropsid Chromosomes. I: The Sexual Difference of Chromosomes in the Pigeon. By Kan Oguma. Pp. 203-227+plates 15-16. (Sapporo.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 835: Thermal Expansion of Graphite. By Peter Hidneth and W. T. Sweeney. Pp. 228-230. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES.

The West Indies: being a Catalogue of Books, Maps and Engravings, relating to British and Foreign Possessions in the West India Islands. (No. 495.) Pp. 42. (London: Francis Edwards.)

Akehurst's Sub-Stage Condenser Changer. Pp. 6. Shop Soiled Apparatus at Reduced Prices: Microscopes, Objectives, Binocular Dissecting Microscopes, Photomicrographs and Projection Apparatus.

Diary of Societies.

SATURDAY, MAY 14.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District Meeting) (at Town Hall, Cleckheaton), at 2.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, Cambridge), at 2.30.—Demonstrations: Crystals of Hemoglobin in intracorpuscular Environment, N. Henderson and G. S. Spencer; Bodies related to Hemoglobin in Vegetable Food Stuffs, D. Keilin; The Preparation of Hemoglobin and its Analogues from their Constituents, R. Hill; Auto-oxidation of Plasma in Anemia, Dr. Litarczek and Dr. Stromberger; The Extra Cutaneous Spleen, Prof. J. Barcroft; The Dissociation Curve of CO Hemoglobin, W. H. Forbes; Apparatus for Measurement of Difference in Potential on two Sides of a Membrane, G. S. Adair; Vital Staining in Living Blood Cells, L. J. Wits and R. A. Webb; The Influence of Relative Proportions of Antigen and Antibody on the Formation of a Precipitate, Prof. H. R. Dean and R. A. Webb; A New Method for Subjecting Developing Organisms to

Temperature Gradients, with some Results on the Development of the Frog, M. Shaw, J. Dean, and M. Tazelaar; Dowling's Electric Micromanometer Adapted to Physiological Purposes, H. J. J. Braddick and B. G. King; A Simple Capillary Electrometer and Recording Camera, Dr. E. D. Adrian; The Discharge of Impulses in the Optic Nerve with Moving and Stationary Visual Fields, Rachel Matthews and E. D. Adrian; The Process of Ovulation in the Rabbit, J. Hammond and A. Walton; (a) Some new Ice-action Velocity Apparatus, (b) The Thermal Measurement of the Rate of Buffering of Acids by Proteins, Prof. H. Hartridge and F. J. W. Roughton.—Communications:—A. N. Richards and J. B. Barnwell: Experiments concerning the Elimination of Phenolsulpho Phthalein by the Kidney.—Sir E. Sharpey-Schafer: On Recovery of Sensation after Severance of Cutaneous Nerves in Man.—J. G. Dusser de Barenne and G. C. E. Burger: A Comparison of the Respiratory Exchange in Man during Static and Phasic Work.—Dr. J. O. Wakelin Barratt: The Action of Hirudin upon Thrombin.—I. de Burgh Daly: A Method of Measuring Small Changes in Electrical Capacity and its Application to the Measurement of Blood Velocity in Closed Tubes.—T. R. and W. Parsons: (a) Oxidation of Serum Constituents; (b) Lipoid-Protein Complexes.—T. Lewis and H. M. Marvin: A Postganglionic Axon Reflex in Human Skin.—L. E. Bayliss, E. A. Muller, and Prof. E. H. Starling: New Determinations of the Respiratory Quotient of the Heart-Lung System.—P. De and W. E. Dixon: Quinine Anaesthesia.—W. E. Dixon and J. H. Wadia: The Action of Thallium on the Skin.—W. A. H. Rushton: The Dependence of the Threshold for Nervous Excitation upon the Position of the Electrodes.—A. R. Fee and A. Hemingway: The Oxygen Usage of the Kidney.—J. Needham: Insulin in Embryogenesis.—B. G. King: Relation of Coronary Outflow to the Length of the Cardiac Cycle.—R. S. Stacey: Relation of Coronary Outflow to Heart Volume.—E. Peserico: Effect of Anovæmia upon Systematic Blood Vessels.—Prof. H. Hartridge and F. J. W. Roughton: The Rate of Buffering of Acids and of Alkalies.—H. Dryerre: The Effect of Successive Injections of Adrenaline upon the Perfusion Rate.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

SUNDAY, MAY 15.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

MONDAY, MAY 16.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in the Botany School, Cambridge), at 4.30.—Dr. J. Needham: The Carbohydrate Metabolism of the Developing Frog Embryo.—O. M. B. Bulman: Some Structural Characters of the Genus *Dictyonema*, Hall, and the Technique Employed in their Determination.—J. S. Yeates: Some Problems in the Comparison of Chromosomes.—*Papers to be communicated by title only*:—M. Abelos: Les théories de la polarité dans les phénomènes de régénération.—Dr. F. H. A. Marshall: The Conditions Governing Parturition.—G. R. de Beer: The Mechanics of Vertebrate Development.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Lieut. Col. F. Molony: A Restatement of the Argument for Theism from Design.

RAILWAY CLUB (at 25 Tothill Street, S.W.), at 7.30.—C. N. Anderson: Some Railway Byways.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Modern Hospital Planning:—H. Percy Adams: English Hospitals.—L. G. Pearson: American Hospitals.

ROYAL GEOGRAPHICAL SOCIETY (at Aeolian Hall), at 8.30.—E. H. de Bunsen: Formosa.

TUESDAY, MAY 17.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—E. T. Elbourne: Trade Association Statistics.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.2), at 6.30.—C. B. Smith: Notes on Swiss Butterflies.—R. M. Wattson: Pre-Reformation Baptismal Fonts.

ROYAL PHOTOGRAPHIC SOCIETY (Colour Group), at 7.—Major A. B. Klein: Colour Photography from the Standpoint of the Painter.

RÖNTGEN SOCIETY (Annual General Meeting) (at British Institute of Radiology), at 8.15.—Dr. R. G. Cantl: An Investigation of the Effects of Beta and Gamma Radiation on Normal and Malignant Tissue Cells Growing in Vitro by Means of the Cinematograph with Demonstrations.—Prof. J. A. Crowther: An Analysis of some Observations on the Action of X-Rays on *Drosophila* Eggs.

WEDNESDAY, MAY 18.

SOCIETY OF GLASS TECHNOLOGY (London Meeting) (at University College), at 2.40.—Dr. G. W. Morey and Dr. N. L. Bowen: The Decomposition of Glass by Water at High Temperatures and Pressures.—Prof. G. Gellhoff: The Brittleness of Glass.—F. Redfern: The New British 15-arm Automatic Suction Bottle Machine.—Standard Durability Tests for Bottles.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section) (Annual General Meeting), at 5.—J. Leveen: Shabbethai Donnolo.—Dr. R. W. Innes Smith: An Unpublished Letter of John Fothergill.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. H. Jeffreys: Cyclones and the General Circulation.—G. M. Meyer: Early Water-mills in Relation to Changes in the Rainfall of East Kent.—S. Morris Bower: Report on Winter Thunderstorms in the British Isles from January 1st to March 31st, 1926.

CHEMICAL SOCIETY (at Royal Institution), at 5.30.—Prof. R. Willstätter: Problems and Methods in Enzyme Research (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—P. K. Turner: A Wireless Works Laboratory.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 7.45.—S. Wernick: The Protective Effect of Metal Deposits on Iron.

ROYAL SOCIETY OF ARTS, at 8.—R. R. Hyde: Industrial Welfare in Great Britain and the United States.

FOLK-LORE SOCIETY (at University College), at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—F. P. Carrel: A New Development of the Ultra-Microscope.—Prof. R. Ruggles Gates and Dr. J. Latter: Observations on the Pollen Development of Two Species of *Lathraea*.—J. Lomax: The Preparation and Examination of Coal Sections.

THURSDAY, MAY 19.

SOCIETY OF GLASS TECHNOLOGY (London Meeting) (at University College), at 2.30.—General Discussion on Furnace Efficiency, in particular on the paper presented by Prof. W. E. S. Turner to the April meeting, namely, A Brief Review of Furnace Developments.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: Studies of the Mercury Band-Spectrum of Long Duration.—Prof. A. Fowler and L. J. Freeman: The Spectrum of Ionised Nitrogen (N II).—Prof. O. W. Richardson: Note on a Connection between the Visible and Ultra-violet Bands of Hydrogen.—D. Jack: The Band Spectrum of Water Vapour.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Mrs. H. Earl, Mrs. T. Edmunds, and A. W. Goodman: What converted me to Birth Control and What I should like to see done for the Movement.

CHEMICAL SOCIETY, at 8.—Dr. H. M. Dawson: New Developments in the Study of Acid Catalysis. The Catalytic Centenary.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, Cavendish Square), at 8.15.—Debate on The Organisation of Medical Research in the Tropics, Prof. Warrington Yorke, Dr. A. T. Stanton.

FRIDAY, MAY 20.

BRITISH PSYCHOLOGICAL SOCIETY (Aesthetics Section) (at Bedford College), at 5.30.—Mrs. Ursula Roberts (Susan Miles): The Functions of the Critic.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (Annual General Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Pictorial Group Meeting.—R. H. Lawton: Individuality.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. L. Bragg: The Structure of the Silicates.

PUBLIC LECTURES.

SUNDAY, MAY 15.

GUILDHOUSE (Eccleston Square, S.W.), at 8.30.—Dr. D. G. Hogarth: The Hittite People and their Civilisation.

MONDAY, MAY 16.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 5.—Prof. J. Fraser: Some Surgical Problems. (Succeeding Lectures on May 17 and 18.)

LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN, at 5.30.—Prof. H. Beckwith Whitehouse: The Menstrual Function, its Physiology and Pathology. (Succeeding Lectures on May 23 and 30.)

TUESDAY, MAY 17.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on May 18, 19, and 20.)

SIR JOHN CASS TECHNICAL INSTITUTE, at 6.30.—Dr. W. H. Hatfield: Special Steels and their Application in Engineering. (Succeeding Lectures on May 31 and June 14.)

WEDNESDAY, MAY 18.

LONDON SCHOOL OF ECONOMICS, at 5.—C. S. Orwin: The Economics of Agriculture. (Succeeding Lectures on May 25 and June 1.)

ROYAL SCHOOL OF MINES, at 5.30.—U. R. Evans: Oxidation, Corrosion, and Passivity of Metals. (Succeeding Lectures on May 25 and June 1.)

THURSDAY, MAY 19.

BRITISH MEDICAL ASSOCIATION (Tavistock Square, W.C.), at 3.30.—Dr. E. Goodall: Some of the Work done to elucidate the Pathology of Disease falling to be considered under the rubric 'Insanity' (Maudsley Lecture).

LONDON HOSPITAL MEDICAL COLLEGE, at 4.15.—Prof. K. Faber: Gastritis, its relation to Achylia and Ulcer (Schorstein Memorial Lecture).

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Lt.-Col. S. P. James: Some Methods and Problems of Malaria Research.

FRIDAY, MAY 20.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.30.—Prof. E. H. Kettle: Inflammation and Infection. (Succeeding Lectures on May 27, 31, and June 3.)

CONGRESSES.

MAY 25 and 26.

FRENCH SOCIETY OF OTO-NEURO-OPHTHALMOLOGY (at Strasbourg).

JUNE 6 to 9.

CONVENTION OF CANADIAN CHEMISTS (at Quebec).



SATURDAY, MAY 21, 1927.

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University Statistics and Tendencies.

SINCE the comparative tables of statistics before us¹ have been compiled by the University Grants Committee, it is but natural that we should turn first to those which shed light upon the financial position. Nor need we make any apology ; for unless that position be sound there can be little expectation that the function of the universities can satisfactorily be discharged. Happily the accounts show a decided and general improvement, particularly when it is noted that only in the case of thirteen institutions has expenditure exceeded income ; and even in these cases the deficits were small and were due to the fact that the institutions concerned met out of income an unusual amount of capital or other non-recurrent expenditure.

The improved position is due largely to increased Treasury grants made upon the recommendation of the Grants Committee, and indicates very clearly that that recommendation has been justified. At first glance the increase in " Government Grant," 35.9 to 39.5 per cent., does not appear to be great, but it has nevertheless been an excellent incentive. Not only have the institutions suffering from a deficit been reduced from twenty-four to thirteen, but also, as the Committee points out, there is another gratifying fact which does not appear in the tables : during 1925-26 reductions of debt to the amount of more than £50,000 were effected. This possesses a special significance when it is observed that increases of salaries of teaching staff cost more than £88,000 ; increases in departmental and laboratory maintenance more than £23,000 ; in general libraries and museums, £24,000 ; in repairs and maintenance of buildings, £38,000 ; in capital expenditure met from income, £57,000 ; and in grants to students' societies, £10,000. The increase of government grants was not, of course, wholly responsible. Income from local education authorities, from endowments, donations, subscriptions, and students' fees, was, in each case, greater than in the preceding year.

With regard to the number of full-time students it may be said that the year has shown a return to what may be normally expected. Actually there is a slight decrease from 41,794 in 1924-25 to 41,443 in 1925-26, but this is largely accounted for by the fall in the number of ex-service students from 263 to 17. Any small aggregate decrease in the number of full-time students is not, as the

¹ University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, 1925-1926. Pp. 24. (London : H.M. Stationery Office, 1927.) 3s. net.

Committee points out, very surprising in view of the prolonged industrial depression; and against that small decrease must be set an encouraging increase in the number entering for the first time upon degree or diploma courses.

Whatever may be the numbers of students, the main interest must be concentrated upon what they are doing; and here there emerge facts which at present we shall not attempt to explain, since they depend upon conditions which are more or less familiar to us all. In the medical, technological, and agricultural groups there is a fall, the decreases being 1000, 152. and 70 respectively. In the pure science group there is a slight increase, while in the arts group there is the substantial increase of 869. As to what specific subjects are proving more or less popular, however, the Committee finds it difficult, for obvious reasons, to carry its analysis far enough. It realises, nevertheless, that it is possible for certain subjects to become rather more popular than is desirable in the national interest. Is philosophy, for example, "not tending to be unduly neglected by our arts students"? Or is chemistry "not tending to attract an unduly large proportion of our science students"?

For our part we do not lack evidence to show that chemistry is, at present, attracting a number of students which may be unduly large. But on the question as to whether this is a matter for alarm or congratulation we do not propose to speak at the moment. We do, however, regret the tendency—and we cannot fail to note that in this age of specialisation it must inevitably increase—for students to neglect philosophy. Nor would we confine that regret solely to the fact that it is neglected by arts students. Philosophy is not the monopoly of any particular group: it is an essential to every student. Let there be no mistake. We are not thinking of it as a form of metaphysics down the tangled by-paths of which we would have science students lose themselves. But if science means, ultimately, an enlargement of experience, we regard philosophy as a critique of that experience.

If we appear to over-emphasise this point in connexion with the courses—in arts or science—of university students, let our excuse be that we claim a lofty view of the function of a university—a view which made us sympathetic, some three or four years ago, with the writer of an article in a prominent university magazine. "Let us learn from others and make our own peculiar gift to the common stock of undergraduate life. If, however, we are not prepared to do this, then let

us at least be honest and call ourselves first-rate teeth-extractors, assiduous engine-wipers, and the like, but not 'varsity men.'"

This matter of the actual subjects followed by university students leads us directly to another important aspect which the present Committee's returns place before us. The whole document seems to us to fall into three main parts: that dealing with accounts, the congratulatory nature of which we have already indicated; that dealing with the subjects and groups of subjects which are being followed in the universities; and that dealing with a matter upon which there is, as yet, little reason to regard as satisfactory. We refer to university libraries. In this connexion a new table of figures has been introduced into the Returns before us. In its general reports in 1921 and 1925, the Committee reminds us, not only was great stress laid upon the importance of well-equipped libraries, but their maintenance and development was insisted upon as one of a university's primary duties, "since defects in this central organ must inevitably have a harmful effect upon the work both of teachers and of students in all departments alike." But the state of affairs revealed by the Library Table, in spite of the fact that a larger sum was spent in 1925-26 than in the preceding year, still presents "an essentially gloomy picture."

In the universities of Great Britain (excluding Oxford and Cambridge) the total expenditure on libraries was £120,616. This sum was made up of £46,280 (salaries), £58,237 (books), £8946 (binding), £7153 (ordinary upkeep). The amount spent upon books by more than fifty institutions of university rank is astonishingly small, and while the Committee is not unaware of the difficulties which beset comparisons between our university conditions and those of other countries, it does not hesitate to justify its phrase "an essentially gloomy picture" by comparison with the United States. We cannot improve the wording of the Committee: "... we could not escape some rather melancholy reflections at finding that for the item of expenditure on books during the academic year 1925-26 the total figure for all our grant-aided universities and colleges put together appeared to be little larger than the combined figure for the universities of Harvard and Yale. . . ."

We said above that our reflections concerning the neglect of philosophy led us directly to the important aspect which the returns show us of university library conditions. We do not imagine that, for those who share our views as to the function of a university, any further explanation is needed.

Physical and Chemical Tables.

International Critical Tables of Numerical Data, Physics, Chemistry and Technology. Prepared under the Auspices of the International Research Council and the National Academy of Sciences by the National Research Council of the United States of America. Editor-in-Chief: Dr. Edward W. Washburn. (Published for the National Research Council.) In 5 vols. Vol. 1. Pp. xx+415. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) Sold in sets only, 12 dollars per vol.

THE volume under review constitutes the first of a series of five volumes of critical tables of numerical data relating to physics, chemistry, and technology. They have been prepared under the auspices of the International Research Council and the U.S. National Academy of Sciences by the National Research Council of the U.S.A., with Dr. Washburn as editor-in-chief. Dr. Washburn has worked through the agency of ten corresponding editors and advisory committees in the leading countries of the world, except Germany.

The bulk of the contributors to the first volume are American; of the fifty names mentioned, thirty-four are American, seven British, three French, two Austrian, two Danish, one Dutch, and one Japanese. The nomination of contributors from Britain was left in the hands of a committee composed of Dr. Kaye (editor), Sir Robert Robertson, Dr. Rosenhain, Prof. Porter, Dr. Stanton, Mr. Sears, Mr. Egerton, with Mr. Higgins as secretary.

Some idea of the magnitude of the venture may be gained from the fact that the editorial, contribution, and manufacturing costs have been appraised at 570,000 dollars. The price per set is 60 dollars, but a special pre-publication offer at 35 dollars per set was made, which brought in orders for nearly 6500 sets. It is interesting to note that only twenty per cent. of these orders came from countries outside the United States, although 150,000 announcements of the offer were mailed to all parts of the world. If any conclusion can be drawn from this return, it is that in the United States there is a large public which can appreciate the value of such an undertaking and has also the purchasing power to acquire copies. The publication of these Tables at a price that would make possible a world-wide distribution, required that the project should be financed by those realising its importance and in a position to make the necessary investment. Some 244 American firms and individuals, and two of the larger

foundations, have provided the sum of 170,000 dollars required for the compilation.

If we may judge the entire work by the standard of the volume under review, then we may say that this work is likely to be of incalculable value to scientific and technical workers, and the organisers and 300 experts have rendered a signal service to mankind by their co-operative effort to render readily accessible the enormous accumulation of data.

It is only when one reflects that until the middle of the last century no attention had been given to the accurate determination of physical and chemical data that one appreciates the tremendous advance that has taken place. In science the accumulated facts make for progress, but the rate at which data are piling up at the present time is such that, unless a systematic effort is made to cope with it, there is a likelihood of a vast amount of human labour being frittered away in unnecessary duplication.

Scanning over the four hundred or so pages of this volume, packed with carefully analysed data, one cannot but marvel at the immense industry of the scientific workers both past and present who have toiled with but one goal in view—the measurement with the highest precision of a physical or a chemical constant.

The dawn of this era of exact measurement was heralded in by a galaxy of mighty experimentalists, amongst whom Stas, Dumas, and Regnault stand out pre-eminently. One recalls the resourcefulness of Stas, who, in order to prepare silver of the highest purity, boldly undertook the task of distilling this metal; the painstaking care of Dumas, who, when making his experiments on the gravimetric composition of water, frequently started an experiment at daybreak and did not see its completion until the dawn of the following day; the meticulous accuracy of Regnault, who, in order to preserve his data, engraved directly on a sheet of polished copper his experimental points and the mean curve through them.

These old pioneers have had worthy successors endowed with added knowledge and the development of fresh instruments. The primary object of these critical tables is to harvest fruit of their toil, sorting the wheat from the chaff, for the benefit of civilisation.

It would be presumptuous to criticise a work such as the volume under review. All one can attempt to do is to offer a few friendly suggestions that might help to make the volume of still greater utility when a further edition is called for.

One feature of the book which immediately impresses the reader is the mechanical perfection of the 'set up.' The arrangement of the tables and the selection of the various sized type leave nothing to be desired. One must, however, point out that the only full-page graph in the volume (page 33) is one which it is impossible to use with comfort. It would have been advantageous to have the data in the form of a nomogram.

The volume opens with a section on national and local systems of weights and measures. The reader can derive much amusement from a study of these; for example, on page 10 the Persian unit of 1 guerze is given as 0.63 m. to 0.97 m.; such elasticity in a unit probably fits in with Eastern notions of buying and selling! It is also of interest to learn that the sacred cubit differs quite considerably from the common cubit. The compilation of this table, occupying fifteen pages, must have involved an immense amount of searching on the part of the compilers.

This is followed by a section on conversion factors and dimensional formulæ. These factors are well arranged and complete, but one does not find a conversion factor familiar to all concerned with thermal conductivity work, namely, for converting thermal conductivities expressed in gram calories per sq. cm. per sec. for 1° C. difference into B.Th.U.'s per sq. ft. per hour for 1 inch thickness and 1° F. difference in temperature. One would like to see B.Th.U. used for British Thermal Unit instead of B.T.U., which is apt to lead to confusion with the Board of Trade electrical unit. Many people prefer to make conversions with the aid of diagrams, so it would have been helpful if reference were made in connexion with this table of conversion factors to the existence of a collection of forty-three graphic tables for the conversion of measurements in different units compiled by R. H. Smith and published in 1895.

We feel that the utility of these volumes could be increased if especial attention had been given to indicate the location of special tables the importance of which is not such as to justify their inclusion in these volumes. For example, it may not be generally known that the annual reports of the British Association contain tables of Bessel functions, sines and cosines of angles in radians, logarithmic Gamma functions, etc., and that the Physical Society has published a table of hyperbolic sines and cosines. Then, again, there is the useful collection of physical and chemical data of nitrogen compounds prepared by the Munitions Inventions Department during the War.

The definition of selected terms occupies nine pages.

We are rather astonished to learn that the Hefner unit is obsolete. Probably the wish is father to the thought! The Hefner is the only official standard for the whole of Germany and has more statutory significance than the standards of Great Britain. As regards the definition of the candle, the author might possibly have expressed himself a little more clearly. It is a unit that is maintained at certain national laboratories in terms of electrical incandescent lamps.

The section on "The Structure of the Isolated Atom" partakes more of the appearance of a scientific paper than the pages of a highly condensed book of reference. Many will question the advisability of quoting Table 2, page 49, from Bohr's book, especially when the subject is in such an unsettled state. It might be noted that Stoner has calculated a table which differs from that given in Table 2. Incidentally, there is a misprint in the middle of this table, 8 being printed instead of 2. The full-page diagram of the normal orbit of the outer electron on page 51 is of more academic interest than practical utility. But the diagram on the preceding page of maximum elongations of electrons of several groups may prove useful in working out optical properties.

The section on resistance thermometers under the main heading "Thermometry" is all too brief. One would like to have found there a table of t and χt to facilitate calculations in the same way as one finds under "Thermocouples" standard tables of temperature and thermo-electric force.

To British ears the statement that "The Callendar equations were devised to facilitate computations by the method of successive approximations" will sound a little strange, even if it is strictly true. It would have been helpful if the writer of the article had indicated the sources where platinum of the requisite degree of purity was obtainable, as it is rather difficult to secure material which complies with the specification he quotes.

In connexion with the article on temperature measurement, it might have been appropriate to point out that certain laboratories supply materials of certified melting points or boiling points which can be used for calibration purposes. A range of pure metals is available for high temperatures and organic compounds for low temperatures.

To the section on optical pyrometry the addition of a table of the emissivities of various substances and a reference to the very detailed charts based on computations from Wien's Law issued by the

Bureau would have been useful. Total radiation pyrometry is not dealt with.

The section on laboratory methods for producing and maintaining constant temperatures should prove of considerable service. The addition of one mixture may be suggested, namely, crushed ice and fuming nitric acid, by means of which -30° can be obtained almost instantly. A reference to the article on the production of cold in the *Journal of the Optical Society of America and Review of Scientific Instruments* would be helpful to the reader.

It is difficult to understand the editor's motives for placing the section "Standard Buffer Solutions and Acid-Base Indicators" in Vol. 1, for they could most appropriately accompany other electrochemical data on ionisation, etc. Wedged at present between a section on "Volume of a Mass of Liquid of known Weight in Air" on one side and "High Vacuum Technique" on the other, it seems out of place.

In the section on "High Vacuum Technique," one might suggest that a note be made to the effect that the expression for the rate of flow of gas through a tube is applicable to within five per cent. only up to a pressure when the free path of the gas molecule is 0.4 times the bore of the tube. No mention is made of Knudsen or of his general equation connecting the rate of flow with the dimensions of the tube. The formula for the molecular flow through a circular opening is not

quite correct; it should be $W = \frac{3.192}{d^2}$; the arithmetical slip occurs in Dushman's original paper.

In the table giving data on various types of pumps, it might be noted that the Gaede molecular pump referred to is now obsolete; no mention is made of the Holweck pump. It is probable that a slip has crept into the table giving pumping speeds of various types of pumps and that the figures in the last line refer to the three-stage Gaede steel pump, for the recently introduced two-stage steel pump will not function against a back pressure of 20 mm. The value 60,000 quoted for the performance of this pump is not one which can be obtained under the usual conditions of operation. It is also rather surprising that no information is given concerning the gauges employed for measuring the pressures. Experience has shown that the normal upper limit of the ionisation gauge is 1/1000 mm., while the Pirani cannot well be employed for pressures below this.

We suggest the addition of a table giving the nature and amounts of various gases to be expected from various typical glasses, metals, and silica when

heated *in vacuo*. The reader would also have been glad to know that, in addition to the substances mentioned, red phosphorus can be used with glass apparatus for removing the residual gas. Other additions which may be suggested are (a) a table of the vapour pressure of the oils used in pumps; (b) a table of the expansion coefficients of glasses and metals suitable for sealing in to glass with tolerance limits.

On page 102, in the table entitled "Elementary Substances and Atmospheric Air," there is a misprint in the value quoted for the viscosity of air. It should be 180.8, not 284.2.

The most important table in the volume is labelled B Table, extending over 55 pages, and gives the important constants of chemical compounds. A point of criticism in regard to this is the order of accuracy to which the molecular weights are given; for example, TiO_2 79.9000, MnF_2 92.9300, $\text{Al}(\text{OH})_3$ 77.9831, LiH 7.94670. One wonders what justification there is for the number of significant figures quoted. Yet it is stated on page 98 that the values given are approximate, and it is proposed to give more accurate values in subsequent sections. A second point is whether some of the substances to which formulæ are ascribed are true compounds; for example, $66\text{PbO} \cdot 21\text{As}_2\text{O}_5 \cdot 12\text{H}_2\text{O}$, 19552.5. Possibly this and countless others are merely 'solid solutions.' No literature references are given in this table.

On page 165 there is a table of refractive indices of numerous compounds, but not of the fundamental elements. It would have been advisable to include the table published in Finnish by J. A. Wasastzerna on ionic refractivities.

On page 357 one finds a section on "Sweetening Agents and Odoriferous Materials" sandwiched between "Dispersoidology" and "Radioactivity"!

Many will feel disposed to question whether the tables on the properties of stars—their distribution and their motion—are physico-chemical data. If astronomical data are to be included, a reference might be given to Brown's tables of the moon, which embodies the results of thirty years of mathematical investigations of a high order. Possibly some day similar tables will become available for the minor planets or asteroids, of which about a thousand are known. Encouragement might thus be given to such monumental pieces of calculation by a reference in a standard book.

The table on X-ray diffraction data from crystals and liquids, page 338, is remarkably complete, but some indication of the accuracy of the data in the

unit cell column is desirable. This subject is advancing at such a prodigious rate that, even in the short time which has elapsed since its publication, quite a formidable array of substances has received investigation in the intervening period. We may mention the following: TiO_2 (anatase), ZrSiO_4 , SnO_2 , MnO_2 , MnF , CaSO_4 , CaWO_4 , CaMoO_4 , BeAl_2O_4 , $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$.

The compilation of the section on aerodynamics, page 404, must have presented unusual difficulties on account of the wealth of material available. It would be advisable in Table 2 on page 404 to indicate that V , means either feet per second or metres per second, according to whether one is reading to the right or the left. Fig. 9 has a misprint in the letterpress: the word Riabouchinski is incomplete. On page 410 (foot of second column) the statement concerning the effect of adding fins might be a little more explicit. It states that adding fins greatly increases the drag of streamline solids; the effect of the fins on the airship R33, for example, put up the drag by eight per cent. The percentage effect would of course be greater if the hull alone was considered.

The reviewer must stress the fact that the various points raised in his review detract little, if anything, from the value of this splendid piece of work. All busy workers are under a profound debt of gratitude to the various experts who have collaborated to produce this unique collection of tables. The best way in which the user can show his appreciation is to indicate to the editors where he considers improvement possible, so that we may look forward to later editions which will embody the best that science has achieved.

The task of compiling this monumental work has obviously necessitated much serious study on the part of the corresponding experts, and, by bringing to bear their critical judgment on the literature, they have discovered serious lacunæ and contradictions. An excellent illustration of this will be found in an article by Bichowsky in the *Journal of Industrial and Engineering Chem.* for April 1926, entitled "The Data of Thermochemistry." There he points out discrepancies which appear in tables generally accepted as standard. As examples he cites Al_2S_3 , the value for which given in the tables should be multiplied by 2, while in the case of $\text{Fe}(\text{NO}_3)_3$ the quoted value should be halved, and numerous other inconsistencies. Again, Washburn, in an address delivered before the American Association for the Advancement of Science, December 1924 (published in *Science*, Jan. 16, 1925), points out "Some Effects of the Atmosphere upon Physical

Measurements" and cites numerous examples of fallacies.

The same state of affairs probably exists in regard to some others of the constants scrutinised, and it would serve a very useful purpose if the experts would publish their findings independently and in greater detail.

EZER GRIFFITHS.

Mechanism and Vitalism.

- (1) *Die anorganischen Grenzgebiete der Biologie (insbesondere der Kristallvergleich)*. Von Hans Przibram: (Sammlung Borntraeger, Band 10.) Pp. 240. (Berlin: Gebrüder Borntraeger, 1926.) 7.50 gold marks.
- (2) *Man not a Machine: a Study of the Finalistic Aspects of Life*. By Prof. Eugenio Rignano. (Psyche Miniatures: General Series, No. 3.) Pp. 77. (London: Kegan Paul and Co., Ltd., 1926.) 2s. 6d. net.

THE perennial conflict between the mechanistic and the vitalistic views of life is illustrated by the two books before us. Prof. Przibram endeavours to persuade us that living beings are governed by the same laws as those which regulate the structure and growth of crystals, whilst Prof. Rignano, the distinguished editor of *Scientia*, is equally certain that the phenomena which subjectively we recognise in our conscious life as memory, are characteristic of all life and afford the most fundamental explanation of the living process. It is somewhat surprising that Przibram, who has a European reputation as an experimental biologist, should be the champion of the mechanistic view, and that Rignano, who was trained as a physicist, should espouse the cause of vitalism.

The comparison of living beings to crystals is one that has often occurred to the minds of biologists, because crystals, like organisms, have a specific form which they preserve, with minor modifications, as they grow; but the difficulties of this comparison are obvious, and until now have appeared insuperable. Crystals grow by accretions to their outer surface; organisms by the interposition of new living molecules amongst those already existing. The additions to the body, like those to crystals, come from the surrounding medium, but the molecules added to a crystal exist as such in the mother liquor and are merely precipitated on the crystal's surface, whereas those that build up the organism are elaborated by the organism itself out of simpler ones which it takes in as food. The crystal is a mass of similar molecules, whereas the organism is composed of different chemical substances arranged

in a definite manner so as to build up a structure which will work.

(1) With extraordinary ingenuity and perseverance Przibram sets himself to surmount these difficulties. He begins by pointing out that although living substance always appears in the form of a colloid whereas crystalline substances are solids, yet almost any crystalline salt can be made to appear as a 'colloid' consisting of a number of minute crystalline particles suspended in the mother liquor. The form in which it will appear depends on its concentration in the solution and the rapidity of evaporation. Further, whilst it is true that in the most familiar crystals growth only occurs at the surface, yet there exist 'fluid crystals' and crystals like those of hæmoglobin and similar organic substances which can imbibe water and in which therefore new molecules can be interposed between those already existing; in these cases Przibram holds that "growth by intussusception" may be said to occur.

The objection that a crystal consists of a repetition of similar molecules is met by what we must regard as a quibble on Przibram's part. He says that molecules do not exist as such in crystals, because all are united in a common lattice-work of atoms, and therefore in going from point to point in a crystal we encounter alternations of different kinds of atoms; and this alternation he compares to the mixture of distinct chemical substances found in all living matter.

With regard to the assimilation of food, Przibram makes a brave attempt to find something like it in crystals. He points out that in certain cases where an optically inactive substance is present in a solution, the presence of a crystal of the dextral or sinistral variety will determine the precipitation of this variety of the substance on the surface of the crystal. Further, when two salts crystallising in somewhat similar forms are mixed in a solution, alternate layers of each may be deposited on the crystal.

Postponing for the moment the question whether or not these analogies are sound, let us look at what Przibram considers the gains of his point of view. He points out that a broken crystal 'regenerates' the missing part, just as many (not all) animals can regenerate an amputated limb; that in some substances the molecular lattice-work is capable of building itself up on alternative forms: thus, substances belonging to the first crystalline system can form cubes or octohedra, and these two forms may tend to appear in the same crystal and thus compete with one another, so that cubes with truncated

angles are often observed. The form which will ultimately prevail is that which grows most slowly, for this requires less material for its realisation; the quickly developing form appears first, but its growth comes to a stop for scarcity of the necessary 'food.' This Przibram compares to the cases where an antenna of an insect is replaced by a leg, a phenomenon termed by the late Dr. Bateson 'hamœosis.' He maintains that the form of the regenerated part depends on the arrangement of the 'lattice-work' of the surrounding tissue; thus the formation of limbs from transplanted rudiments in *Amblystoma*, as evidenced by his own repetition of Harrison's experiments, is governed by the structure of the skin surrounding the rudiment and not by the relation of the new organ to the 'whole,' as Driesch has asserted. He shows that two fluid crystals will coalesce into one as do two blastulæ of *Echinus*, and he says that Driesch's conundrum of the impossibility of conceiving a machine which by division will give rise to two similar machines is answered by the lattice-work of a crystal, for this if broken into two will regenerate two similar crystals.

We recommend this work of Przibram to the careful attention of all our readers; they will find it a mine of information on the physics of crystals, though it is to be regretted that he only mentions Sir William Bragg's name once, and no one would gather from a perusal of the book that we owe nearly all our modern knowledge of crystal structure to Bragg's discoveries.

Przibram has, however, failed to convince us of the validity and worth of the comparison of the structure of living beings with crystals, and if he with all his knowledge of biology has failed, no one else is likely to succeed. To give a detailed destructive criticism of all his arguments would occupy too much space, but some of the principal objections which occur to us may be noted. Thus it is misleading to compare a colloid solution of an inorganic salt such as ferric chloride with the colloids of living bodies. The former is a suspensoid—really a minutely divided precipitate—the latter a di-phasic or even triphasic emulsoid of different fluids enclosing one another, and the physics of the two states are, as Hardy has shown, quite different. The citation of fluid crystals is irrelevant. The term 'fluid crystal' is a misleading one to denote an intermediate phase between complete fluidity and definite crystallisation which is exhibited by certain organic substances. In this condition—stable over only a narrow range of temperature—the molecules of the substance roll over one another,

so that it is a fluid, but these molecules are sufficiently close to exert such an influence on one another as to keep their optical axes parallel. It is really a drop of turbid fluid, of which the turbidity is due to crystalline particles. The fundamental objection, however, is that a crystal is a relatively static form of material, whilst every particle of a living being, so long as it is alive, is in a continual state of destruction and reconstitution, and this reconstitution is effected from relatively simple materials. Nothing at all similar to the miracle of assimilation is to be found outside the domain of life.

(2) It is with this miracle that Rignano begins his book "Man not a Machine." The building up of new protoplasm from food he regards as one example of that 'purposeful striving' which is the inner nature not only of man but also of all life. In this case it is a striving to maintain a certain dynamic equilibrium. Prof. Leathes in his address to the Physiological Section of the British Association last summer pointed out that, given the known compounds into which food is broken by digestion, the number of ways in which they could be strung together runs into countless millions of millions, and yet they are put together in one particular way and no other. Rignano goes on to show that ontogeny, or the development of the individual, is likewise a striving to reach a typical end. It was indeed the recognition of this fact, and of the tendency of the egg to reach this end even when mutilated, by the adaptation of parts to purposes to which in normal circumstances they never would be put, which converted Driesch from being an adherent of Weismann to a vitalistic position.

The whole life of an organism and its movements are, as Rignano asserts, one continued striving to maintain around it the accustomed environment. When living matter is exposed to a new environment "it has no rest until it has either re-established the old environment or becomes adapted to the new one," that is, until it succeeds in establishing a new equilibrium. Adaptation to a new environment is attained by a constant series of trials—but when once it is attained the reappearance of the same conditions call forth the successful response with ever-increasing rapidity. It is this peculiarity of living matter which Rignano calls memory and which accounts for the inheritance of acquired characters. It corresponds to what the reviewer has elsewhere called 'habitudinal memory.' Rignano tries to explain it by his theory of 'specific accumulation,' which is at any rate a plausible one. It is to the effect that every reaction leaves behind

it in all the nuclei of the reacting animal a deposit or trace, the effect of which is to accelerate the production of the same reaction when the same circumstances recur. The continual reaction to a stereotyped situation becomes a reflex or instinct, and the reflex is thus not the primary building stone out of which the actions of an animal are built up, as many physiologists have supposed, but merely the result of long-continued repetition.

The application of these principles to the life of man occupies the last chapters of the book. For the detailed criticism and analysis of these chapters we have no space, but we can sum up the controversy between vitalism and mechanism somewhat as follows. *All scientific reasoning is comparison*, starting with what is relatively known and familiar, or with what we imagine to be so, and we strive to compare with it the more complicated and unfamiliar. The mechanistic biologist, taking as familiar the chemical reactions which go on in a test-tube, seeks to reduce the life around him (and incidentally his own) to a combination of these, determined by the juxtaposition of unlike substances, that is, by structure. The vitalist is impressed with the most thrilling of all the facts in biology, namely, the fact that he himself is alive. The life of this one being he knows from the inside, and he thinks it logical to compare with this life the life of other beings, so that a certain measure of qualified anthropomorphism seems to him to be the only rational way of dealing with life.

After all, it is doubtful whether in the last resort Przibram seriously regards himself as a magnified crystal, and, as Dr. Broad has recently said, "the man who asserts that his brother—or his cat—is merely a mechanism, is either a fool—or a physiologist." Dr. Bateson once said: "If to be a vitalist is to admit that here and now we cannot explain the actions of living beings by physics and chemistry, who would not be a vitalist?" It may be held that to accept any form of vitalism is to sterilise biology and that only the mechanistic hypothesis leads to results; but in zoology, at any rate, this is not true. In studying the physics and chemistry of the cell we are studying the tools of life, not life itself, and 'mechanistic' theories of heredity have only led to the creation of a welter of incomprehensible 'genes,' the nature and origin of which are mysterious: real light on the inner nature and evolution of animal life has only come from following the lead of the concepts of striving, habit and memory.

E. W. M.

Our Bookshelf.

The Memory Factor in Biology: a Sketch of the Unity of Life. By Prof. C. J. Patten. Pp. xiii + 175. (London: Baillière, Tindall and Cox, Ltd., 1926.) 5s. net.

PROF. PATTEN is an enthusiastic supporter of the mnemonic theory of life and heredity which is associated with the names of Hering, Samuel Butler, Francis Darwin, and Semon. His little book is very readable and contains much matter within a small compass. The theses put forward are "that Memory is indeed the Mainspring of Organic Evolution, and also that it is the source and potentiality which unifies both consciously and unconsciously the Psychic side of all living organisms; that vital activities, morphological as well as physiological, are in truth Psychic manifestations; that even the simplest vital activities are quite purposive; that Memory is rhythmic in character; that the processes at work in the evolution both of the Individual and of the Race furnish evidence of being an unbroken chain of Memory Processes, and are, in the main, due to Habit Formation; and lastly, that Memory Processes, when analysed mainly in regard to their physical basis, cast a strong beam of light upon the advocacy of Somatic Inheritance" (p. xii).

One might conclude from this citation that Prof. Patten is a psychobiologist, and indeed he comes very near to that position. On one cardinal point he is quite emphatic, "that unless one postulates the presence of a Psychic side in all living things any attempt to explain Memory phenomena on rational lines would signally break down" (p. xi). But the philosophical position he adopts is apparently that of monism, of the rather vague Haeckelian kind, which is by no means free from the dualistic taint that Prof. Patten has in horror. So it comes about that in elaborating the memory theory he falls back upon the "physical trace" or "engramm" conception of Richard Semon: he tries, in other words, to translate what is essentially a psychical activity into its presumed physical correlate.

For our own part we hold with James Ward that a memory theory of heredity will not work unless based frankly upon a psychological theory of life, and freed from the mechanistic preconception of physical traces. But it must be confessed that no one as yet has successfully worked out such a theory.

E. S. R.

Industrial Fermentations. By Prof. Paul W. Allen. Pp. 424. (New York: The Chemical Catalog Co., Inc., 1926.) 5 dollars.

PARAPHRASING the author's statement in his preface, this book is not intended for those who require special knowledge on the subjects it deals with, but its intention is "to bring together in a general way some of our present information concerning the application of micro-organisms to industry." Taking this fully into account, after having read the book, we must confess ourselves disappointed. The text is divided into thirty-one

chapters, each dealing with some special applications of micro-organisms to industrial processes. To those who are acquainted with only some of these processes, the task of giving even a general account of so wide a field in so small a compass will appear at once Utopian.

The book contains useful information, but a perusal of the text justifies our criticism. Under "Leather and Tanning" the processes preceding the tanning are described briefly but accurately, whilst tanning itself occupies but twelve lines; and here there is no mention of the use of tannin extracts, or of chromium compounds, formaldehyde, etc., treatment of the hide or skin with a mixture of fish and other oils only being referred to. Bread-making occupies forty pages and gives some useful outlines of the processes employed. We are left in doubt, however, as to the meaning of the following sentences (p. 133): "The particular kind of yeast which is of interest to the bread maker is *Saccharomyces cerevisiae*. . . . These organisms are divided into three groups: bottom yeasts of German beers, top yeasts used in making English beers, and distillery yeasts. . . . These are the yeasts generally used in the manufacture of bread." If the author refers to all three, his statements are incorrect. Nor do we obtain any further help in this connexion in the chapter on "Bread Yeast Manufacture" (p. 311). The chapter on the manufacture of industrial alcohol introduces much matter of a purely academic character, but the text will be of little assistance to the general reader who wishes to gain an insight into the industrial processes. A useful feature of the book is the appendage to each chapter of references to the literature.

A. R. L.

Marine Works: a Practical Treatise for Maritime Engineers, Landowners and Public Authorities. By Ernest Latham. Second edition, considerably enlarged. Pp. xii + 223. (London: Crosby Lockwood and Son, 1926.) 16s. net.

THE second edition of this work consists of two parts, the first of which is identical with the earlier edition and the second is made up of three additional chapters. We have not been able to find any alteration in the first part, and it is accordingly open to the same criticisms as were expressed in the review which appeared in NATURE of Mar. 3, 1923 (p. 285).

As regards the additional matter, Chap. x. deals with quays and jetties in tidal waters and is obviously supplementary to Chap. ix. on deep-water quays. It consists of certain somewhat disconnected jottings on costs and valuations and modern practice in design. It contains, however, a timely and salutary admonition on the economical aspect of the selection of a site for the exploitation of a river frontage, and points out the advantages accruing from the use of runways and other modern transportation facilities. There is a note of a method advocated by the author for the determination of the actual volume of dredged material in computing payments to a dredging contractor. This point crops up again in the next chapter but

one, where the same ground is covered, indicating a lack of care in avoiding repetition, which is almost inevitable when articles on the same, or kindred, subjects are reprinted *in toto* from journals.

The weakness of the book as a whole, in fact, is that it consists of a series of such articles, useful and interesting in their way, but discursive, disjointed, and, in some measure, superficial. Chap. xi. deals with coast erosion; here again the information contained would have been more appropriately blended with that in Chap. vi. on coast defence. The concluding chapter (xii.) discusses dredging and land reclamation. There is a useful appendix on "The Land Drainage Acts examined from the engineer's standpoint," reprinted from *Water and Water Engineering*. B. C.

General Botany: with Special Reference to its Economic Aspects. By Dr. C. Stuart Gager. With three Chapters on Heredity and Variation in Plants, by Dr. Orland E. White. Pp. xvi+1056. (Philadelphia, Pa.: P. Blakiston's Son and Co., 1926.) 4 dollars net.

THIS is a text-book written along very different lines from the majority of books used as introductions to the study of botany. The work gives the impression that its author has not considered college and examination syllabuses, but has attempted to deal with botany as an indispensable subject of general education. It must be acknowledged that he has largely succeeded in showing that plant life has been throughout history, and still is, closely interwoven with human life.

A general introduction is followed by four parts, subdivided into forty-one chapters, dealing respectively with the vegetative functions of plants, reproduction and life-histories, the great groups of seed-bearing plants, and genetics and evolution. Features of special interest are: the excellent photographic reproductions, the insertion of short historical and biographical notes, and the discussion at every opportunity of the relationship of plants to human affairs. A few of the text figures are not quite accurate and several unfortunate slips in terminology have been noted. The majority of the bibliographical references are to American papers and books, and, naturally, most space is devoted to American genera and species. Nevertheless, this text-book is one that should be of great use to teachers and students not only in the United States but also outside.

The New Book of Trees. By Marcus Woodward. Illustrated with Wood Engravings by C. Dillon McGurk. Pp. 310. (London: A. M. Philpot, Ltd., n.d.) 12s. 6d. net.

THE author of this work does not attempt to give elaborate scientific descriptions of trees, neither does he try to reveal anything that is new; rather, by delving into ancient tomes, he has brought to light much that is old but interesting. His researches are confined to the commoner kinds of trees and shrubs, and more particularly to native species. He has gathered together a good deal of historical information, and the chapter entitled "Remarks on Forest Scenery" is particularly

interesting, dealing as it does with English woodlands from the time of the Roman invasion to modern times. In his descriptions of the various species the author makes good use of the many legends and lyrics concerning trees and forests that are to be found in old sylvicultural works.

Whilst the book is not one to recommend to the student of botany or silviculture, it is well worth a place upon the shelves of other tree-lovers, whilst people who have no special interest in trees will find much interesting reading. There are numerous good engravings by Mr. C. Dillon McGurk, and both printing and paper are good.

Hydrogen Ion Concentration of the Blood in Health and Disease. By Prof. J. Harold Austin and Prof. Glenn E. Cullen. (Medicine Monographs, Vol. 8.) Pp. xi+75. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 9s. net.

IN this monograph the authors have set out to give a brief account of our present knowledge of the hydrogen ion concentration of the blood. In the first chapter there is a short but complete theoretical survey of the subject; whilst in the last, methods of determining pH are briefly described. The second chapter gives our knowledge of normal blood pH, and the third, which accounts for half the length of the book, describes the variations met with in disease. The authors have confined themselves strictly to the subject in hand, though, even then, more than two hundred references are given in the bibliography. They also assume a fair knowledge of the subject from their readers: the clarity of certain portions of the monograph, especially those dealing with the more theoretical aspects of the subject, would be enhanced by somewhat fuller descriptions. The book should be of use to all those interested in the subject, as a work of reference to the latest researches.

The Chemistry of Dyeing. By Dr. J. K. Wood. (Chemical Monographs, No. 2.) New and revised edition. Pp. vii+104. (London: Gurney and Jackson, 1926.) 3s. 6d. net.

THIS monograph, first issued in 1913, was written primarily for advanced students, but is of great interest to all who are engaged in processes involving dyeing. Commencing with a description of the physical and chemical properties of the more important commercial fibres, the book gives a short description of the principal types of dyestuffs and the methods of applying them to the various types of fibres. This is necessary in order to understand the following chapters, which deal with the numerous theories which have been advanced concerning the actual mechanism of the dyeing process. These theories are very lucidly explained with great attention to experimental evidence, starting from the first idea of a purely mechanical process to the modern conception of dyeing as a dual process, involving first the electrical precipitation of the dye on the fibre and then the chemical combination or physical solution in the cell walls. The references to the published literature are unusually copious.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Simultaneous Ionisation and Excitation by Foreign Ions in a Gaseous Mixture.

WE have recently carried out some experiments which indicate that an ion of one kind may, upon collision with a molecule of another gas, ionise that molecule and excite the resulting ion to the degree that the energy required to ionise the one exceeds the energy required to ionise the other. This means that an ion may rob a molecule of an electron, and at the same time give to the resulting ion the excess of energy made available by its recombination with the electron over the amount needed to take that electron out of the molecule. As the energies of excitation are quantised, there is usually still a remnant of the energy of recombination yet to be accounted for, and this probably goes into increased kinetic energy of one or both particles involved in the collision.

The experiments have been limited to mixtures of carbon monoxide and of nitrogen with argon, neon, and helium, but the same process may occur in any mixture of gases and vapours, monatomic or multi-atomic. We used carbon monoxide in particular because the energy levels of the CO molecule and the CO⁺ ion have recently been experimentally determined in this laboratory¹ and interpreted on the basis of the quantum theory of band spectra.² Spectrograms were taken with a Hilger E2 quartz spectrograph of low voltage arcs of 40 milliamperes at 23 volts in a hot cathode discharge tube through mixtures of argon, neon, and helium in turn, each containing ten per cent. of carbon monoxide. The total pressure of the mixture was 2.4 mm. in each case. An auxiliary filament was mounted near the cathode filament so that electrons could be introduced into the discharge from it when desired. The purpose of the auxiliary filament was to enable us to determine whether the carbon monoxide bands were being excited by the rare gas ions or by the electrons from the cathode, and whether the excitation was accomplished simultaneously with the ionisation or was a subsequent event.

The spectrograms show that, in the argon mixtures, none of the negative bands of carbon monoxide or of nitrogen is excited; in the carbon monoxide-neon mixtures the comet tail bands and the first negative bands of CO⁺ appear, the former strongly and the latter weakly, but the Baldet-Johnson bands are absent; in the helium mixture all three negative systems of carbon monoxide are strongly developed. The negative bands of nitrogen appear fairly strong in the nitrogen-neon mixture and very strong in the mixture with helium.

Before it could be concluded that these negative bands were being excited simultaneously with the ionisation of the molecule on collision with an ion of neon or of helium, several alternative possibilities had to be tested:

1. The excitation of the ion might follow as a later event after the molecule had been ionised by the rare gas ion. That this process was not operative was demonstrated by introducing into the discharge, electrons from the auxiliary filament at a voltage

sufficiently great to excite the CO⁺ ions on collision. Although the electron current from this filament was twice as great as from the cathode, no increase in the intensities of the negative bands was produced. Thus, though the current through the discharge was three times as great as before, the negative bands were no more intense. On the other hand, the positive bands of carbon monoxide, which were not present in the original discharge, appeared with moderate strength in the discharge with the auxiliary filament in operation, when the difference of potential between the auxiliary filament and anode was equal to the excitation potentials of these bands. The second positive bands of nitrogen were present even though the auxiliary filament was not used, but their intensities increased enormously when the voltage of the auxiliary filament reached their excitation potential. This suggests a new method for determining the excitation potentials of positive bands and arc lines.

2. The simultaneous ionisation and excitation of the carbon monoxide molecule might be due to direct electron impact, as has been demonstrated to be possible.¹ That this was not the case was proved by maintaining the voltage of the auxiliary filament higher than the excitation potentials of these bands but below the ionising potential of neon. In this way the possibility of excitation by electron impacts was increased threefold, while the concentration of neon ions was increased very little. A barely perceptible increase in the intensities of the negative bands was observed when the current from the auxiliary filament was twice as great as from the cathode.

3. The ionisation and excitation might be due to an impact of the second kind with an excited neon or helium atom. It was for the purpose of determining whether the ion or an excited atom of the rare gas was responsible for the observed phenomena that nitrogen was substituted for carbon monoxide in the neon mixture. The excitation potential of the negative band system of nitrogen is greater than either of the strong radiating potentials of neon, but is less than the ionising potential of neon. Therefore, an excited neon atom could not ionise the nitrogen molecule and simultaneously excite its negative bands. Hence we must conclude that it is the rare gas ions that were effective.

The interpretation of the observed results on the basis of simultaneous ionisation and excitation by the ions of the inert gases is fairly obvious upon consideration of the excitation potentials of the bands involved and the ionisation potentials of argon, neon, and helium as given in the following table:

Band System.	Excit. Pct.	Gas.	Ionis. Pot.
Comet Tail . . .	16.8	Argon	15.4
First Negative . .	20.0	Neon	21.5
Baldet-Johnson . .	22.9	Helium	24.5
		Carbon Monoxide	14.3

Thus none of the negative bands of carbon monoxide would be expected to appear in the argon mixture, while the comet tail bands and the first negative bands would be excited by neon ions, and all three systems by helium ions, as was observed.

Apparently the neon ions are more efficient in exciting the comet tail bands than they are in exciting the first negative bands. This greater probability that the former would be excited rather than the latter upon a collision between a neon ion and carbon monoxide molecule would seem to indicate that the efficiency of ions in this type of

¹ Duffendack and Fox, *Science*, 64, p. 277; 1926; *Astrophys. Jour.*, in press.

² Birge, *NATURE*, 117, pp. 229, 300; 1926; *Phys. Rev.*, 28, p. 1157; 1926; Johnson, *NATURE*, 117, 376; 1926; Duffendack and Fox, *NATURE*, 118, 12; 1926.

excitation increases, at least for a time, as the excess energy available increases. This view is supported by the fact that all three systems are strongly developed in the helium mixture. Several bands belonging to the comet tail and Baldet-Johnson systems not previously reported were observed in our spectrograms of the carbon monoxide-helium mixture.

The failure of the Baldet-Johnson bands to appear in the neon mixture and their strong development in the helium mixture is significant. According to Birge,³ these bands constitute a combination system between the initial states of the first negative and the comet tail systems. If this were true, they would have the same excitation potential as the first negative bands and should be excited by neon ions. Their experimentally determined excitation potential¹ is in agreement with their behaviour in the neon and helium mixtures. This confirms the assignment of this system to a higher initial state of the CO⁺ ion as made by Duffendack and Fox.² It might be added that Miss Ann Hepburn, at the Chicago meeting of the American Physical Society, corrected her published abstract⁴ and reported the excitation potential of this system to be 23.0 volts, in agreement with the value given above.

The appearance of the negative band systems of carbon monoxide and of nitrogen in our discharges is in harmony with their appearance in geissler tube discharges through similar mixtures as observed by Merton and Johnson⁵ and by Cameron.⁶ Their presence can be accounted for on the basis outlined above, and slight discrepancies can be explained by the less definite limitation of the maximum speeds of the electrons in geissler discharges. Similar discrepancies can be produced in our discharges by increasing the voltage, or the current density, or the percentage of carbon monoxide, or in any way increasing the probability of excitation of the carbon monoxide molecules by direct electron impacts.

There is no reason to believe that this method of excitation of radiation from an ionised molecule is limited to the ions of the rare gases or to multi-atomic molecules. The same process may be expected to occur in any mixture of gases or vapours, and should find application in the production of the first spark spectra of atomic ions to the exclusion of higher spark spectra, and in the approximate determination of the excitation potentials of the spark lines. This process may also explain the enhancement of certain lines in discharges through mixtures of gases and the origin of certain radiations of astronomical interest.

We wish to express our gratitude to Dr. W. E. Forsythe of the Nela Research Laboratory (where these experiments were begun during the summer of 1926) for the argon, and to the U.S. Bureau of Mines for the helium used in these experiments.

O. S. DUFFENDACK.
H. L. SMITH.

University of Michigan,
Ann Arbor, Mar. 15.

Spinning Electron and Wave Mechanics.

In order to obtain an interpretation of the anomalous Zeeman effect, the multiplet structure, etc., Uhlenbeck and Goudsmit (*Physika*, 1925; *Naturw.*, 953, 1925; *NATURE*, 117, 264; cf. Thomas, *NATURE*, 117, 514; Slater, *NATURE*, 117, 587; London, *Naturw.*, 15, 15, 1927; Darwin, *NATURE*, 119, 282) assume that the magnetic moment corresponding to the spinning

movement of the electron is just twice as great as that of the revolving electric point-charge with the same mechanical angular momentum. In the following, an attempt is made to derive this assumption from the relativistic Schrödinger wave equation in connexion with the electrodynamic meaning of the wave function ψ .

The relativistic wave equation for forceless movement of the electron is:

$$\Delta\psi - \frac{1}{c^2} \frac{\partial^2 \psi}{\partial t^2} - \frac{4\pi^2}{h^2} m_0^2 c^2 \psi = 0. \quad (1)$$

(Schrödinger, *Ann. d. Ph.*, 81, 133, and other authors.) The solution, in the rest-system of the electron, may be reduced to the following form (r, z, ϕ being columnar co-ordinates, which are suitable to the purpose):

$$\psi = f(r, z) \exp. i s \phi \exp. \frac{2\pi i}{h} m_0 c^2 t \left\{ \begin{array}{l} \\ = F(r, z, \phi) \exp. \frac{2\pi i}{h} m_0 c^2 t \end{array} \right\}. \quad (2)$$

F satisfies the equation: $\Delta F = 0$, and is therefore harmonic in the rest-system.

The equation of the continuity of electricity is:

$$\text{div.} \left\{ \frac{h}{2\pi i} (\psi \text{ grad. } \bar{\psi} - \bar{\psi} \text{ grad. } \psi) \right\} + \frac{\partial}{\partial t} \left\{ -\frac{h}{2\pi i} \frac{1}{c^2} \left(\psi \frac{\partial \bar{\psi}}{\partial t} - \bar{\psi} \frac{\partial \psi}{\partial t} \right) \right\} = 0. \quad (3)$$

(See W. Gordon, *Zs. f. Phys.*, 41, 117, see p. 121, and O. Klein, *ibid.*, 41, 407, see p. 414.)

We multiply the expressions in brackets by the specific charge $\frac{e}{m_0}$ of the electron (the introduction of the factor $\frac{1}{2}$ —as introduced by Klein—cannot be justified in our case) and get for the electric density:

$$\rho = \frac{e}{m_0} \left\{ -\frac{h}{2\pi i} \frac{1}{c^2} \left(\psi \frac{\partial \bar{\psi}}{\partial t} - \bar{\psi} \frac{\partial \psi}{\partial t} \right) \right\}, \quad (4a)$$

and for the density of current:

$$j = \frac{eh}{2\pi i m_0} (\psi \text{ grad. } \bar{\psi} - \bar{\psi} \text{ grad. } \psi). \quad (4)$$

From the non-relativistic form of the wave equation only half the density of current follows (cf. Schrödinger, *l.c.*). From that Fermi (*NATURE*, 118, 876) and Klein (*Zs. f. Phys.*, 41, 425) have derived the magnetic moment for the revolving movement of an electric point-charge, namely:

$$\mu' = -\frac{e}{m_0} \frac{h}{4\pi} s', \quad (5')$$

whilst the magnetic moment corresponding to the density of current (4) is:

$$\mu = -\frac{2e}{m_0} \frac{h}{4\pi} s \quad (5)$$

μ may be regarded as the magnetic moment of the spinning movement, being twice as great as μ' in agreement with the assumption mentioned in the beginning. The conjectures of Slater and London that the rest-energy $m_0 c^2$ is of rotatory character and that the 'internal phenomenon' of L. de Broglie of the frequency $\nu_0 = \frac{m_0 c^2}{h}$ causes it and therefore the magnetism of the electron itself, are supported by this.

The necessary half quantum-numbers for s follow readily if one adapts the Schrödinger conditions for the wave function ψ to our problem.

Only the doublet ($\frac{1}{2}$, $-\frac{1}{2}$) and no higher quantum-states of rotation appear.

We hope, in an early communication, to return to the question of fine structure and analogous problems.

E. GUTH.

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³ Birge, *NATURE*, 116, 207; 1925.
⁴ Hepburn, *Phys. Rev.*, 29, 212; 1926.
⁵ Merton and Johnson, *Roy. Soc. Proc., A*, 103, 383, 1923; Johnson and Cameron, *ibid.*, 106, 195; 1924; Johnson, *ibid.*, 108, 343; 1925.
⁶ Cameron, *Phil. Mag.*, 1, 405; 1926.

Occurrence of Branched Hairs in Cotton and upon *Gossypium Stocksii*.

IN the columns of NATURE of Mar. 12, p. 392, Mr. N. W. Barritt describes branched hairs in a specimen of Egyptian cotton. Such branched hairs of *Gossypium* have been known to us for some time and have been the subject of an investigation by us which we hope shortly to publish.

We have growing here each year in our experimental area what is probably the most representative

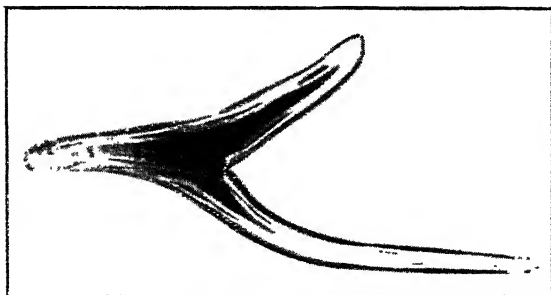


FIG. 1.—Branched hair of *Thespesia populnea*, 0.9 mm. long.

collection of Asiatic types of cotton to be found anywhere in the world. Amongst several of these types, by the exercise of patience, we have found these branched hairs, as also in Upland American and Sea Island types. The branched hair represents a form of hair that occurred in the phylogeny of the Hibiscæ. It is very well seen in *Thespesia populnea*, upon the seed coat of which there are hairs of at least

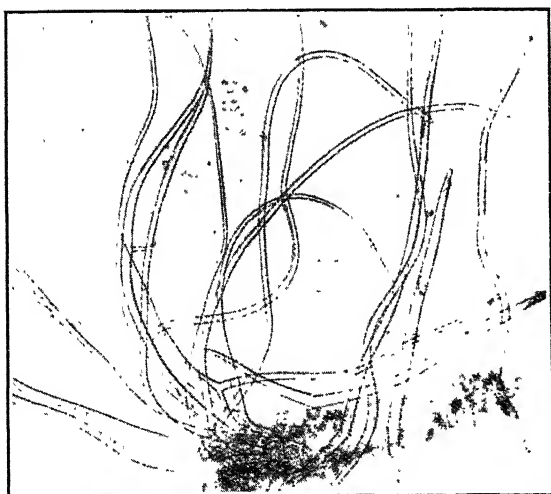


FIG. 2.—Branched hairs of *Gossypium Stocksii*.

two types, one of which is branched and another unbranched. The branched type is shown in the photomicrograph (Fig. 1). The length of this hair is 0.9 mm.

In *Gossypium Stocksii*, a type of cotton in some respects primitive, hairs occur within the capsule not only upon the seed coat but also upon the capsule wall. Many of these hairs, both upon the seed coat and the capsule wall, show branching. These are shown in Fig. 2. Coming off from the mass of capsule wall shown in this photograph is a bifurcate hair with a very short basal part embedded in the wall. To the left of this is another similar one with

a longer base than the former. Hairs with shorter side branches can be seen in several places. The hairs on the seed coat of *Gossypium Stocksii* are usually regarded as of the nature of 'fuzz.' In our material they are some 8 mm. to 10 mm. long.

It seems probable that in the modern forms of *Gossypium* the branched hair has become suppressed, and usually develops only tardily and to a limited extent in the form of 'fuzz.'

We have *Gossypium Stocksii* from the Sind Desert growing and flowering here now. There are several characters in it that have never been correctly described. In our material there are no signs of any stipular glands at the base of the clawed bracteoles as figured in Watt's "Wild and Cultivated Cotton-Plants of the World." The flowers of our material, too, could not be described as 'large'; in comparison with most other Asiatic cottons, they are small. In colour the flowers are pale sulphur yellow and of a totally different shade from that of Asiatic cottons generally. The pollen grains, in the character of their spines, differ from those of any other Asiatic *Gossypium* seen by us. An investigation has been made into the cytology of *Gossypium Stocksii*, and thirteen chromosome bodies have been found in the developing pollen grain.

W. YOUNGMAN.
S. S. PANDE.

Agricultural Research Institute,
Nagpur, India.

Intensities of Molecular Beams.

KNAUER and Stern (*Zs. f. Phys.*, 39, 775) have recently investigated the relation between the intensity of a beam of mercury molecules and the pressure in the oven or source chamber. They have found that the intensity of the beam increased uniformly with the oven pressure, until the mean free path in the oven was about equal to the width of the oven slit. At this pressure the beam had a maximum intensity, becoming less intense as the oven pressure was increased above this optimum value. As an explanation of this maximum, they have suggested that the molecules emerging from the slit, at pressures greater than the optimum pressure, collide with one another, giving rise to the formation of a cloud in front of the slit. Instead of originating in the slit itself, the beam then has its source in this diffuse surface of low intensity.

This explanation does not seem correct, when a consideration is made of the frequency of the collisions taking place between the molecules which have passed through the oven slit. An indication of the probability of such collisions may be gained from a calculation of the free path in an ideal gas the molecules of which are moving in a single direction with a Maxwellian velocity distribution. The result of such a calculation shows that the mutual collisions between the molecules within the beam are so infrequent as to produce no appreciable effect on the intensity of the beam, except at oven pressures far greater than the optimum pressure observed by Knauer and Stern. The diminishing intensity of their beam, as the pressure was raised above the optimum pressure, was more probably due to scattering by molecules which had been reflected from the uncooled walls of the chamber between the slits. The reason for this statement will appear from the following experiments.

A beam of mercury molecules was formed in a manner similar to that of Knauer and Stern, with the important difference that the region between the two slits was entirely surrounded by a liquid air cooled surface. In this way all molecules were removed from this space at their first impact with the walls, with the

exception of a small fraction which were striking an uncooled surface near the image slit. The slits were each 0.1 mm. wide by 1 mm. long and were separated by a distance of 7 cm. The intensity of the beam was measured by means of an ionisation gauge, having as its only opening a slit of the same dimensions as of the two referred to above. The gauge was mounted in the vacuum in such a manner that it could be moved into or out of the beam at a point 8 cm. beyond the image slit. The change of pressure which took place in the ionisation gauge, when it was moved from a position outside of the beam into its centre, was assumed to be proportional to the intensity of the beam.

With this arrangement a beam could be detected when the oven pressure was 0.1 mm., a pressure slightly below that at which a maximum would be expected to occur, if the interpretation which Knauer and Stern have placed upon their results is correct. It was found, however, that with oven pressures ranging from 0.1 mm. up to 30 mm., the beam intensity increased uniformly with the oven pressure. Within this pressure range the beam was well defined and had the width calculated from the geometry of the slits. At oven pressures greater than 30 mm., the beam intensity increased more slowly with the pressure, and passed through a maximum at an oven pressure of 100 mm. Within this range the beam gradually became more diffuse, until at the last pressure it was several times its geometric width.

The maximum may be analogous to the maximum observed by Knauer and Stern; it is possibly due to scattering by molecules which have been reflected from the small uncooled area near the image slit. The more complete elimination of such reflected molecules accounts for the fact that the maximum occurred at an oven pressure about one thousand times greater than that predicted by Knauer and Stern.

The mutual collisions referred to above are also an important cause of scattering at these large beam intensities. For this reason the production of a beam of greater intensity will not be materially aided by a further elimination of the reflection of molecules from the walls of the chamber between the two slits.

THOMAS H. JOHNSON.

Sloane Physical Laboratory,
Yale University, April 22.

The Mechanism of 'Knock' Suppression.

THE letter by Messrs. Egerton and Gates in the issue of Mar. 19, p. 427, concerning the mechanism of 'knock' suppressors such as lead tetra-ethyl, prompts me to add certain points of view material to the discussion.

The idea that lead tetra-ethyl acts as an inhibitor of the oxidation of aldehydes was expressed by me in January 1924 at a meeting of the North-Eastern Section of the American Chemical Society in Boston, reported in the News Edition of *Industrial and Engineering Chemistry* for February 1924, and in *Chemical and Metallurgical Engineering*, vol. 30, p. 148 (1924). At that meeting I was able to show an experiment in which the rate of oxidation of 5 c.c. of benzaldehyde was decreased from 1.5 c.c. absorbed oxygen per minute to 0.005 c.c. per minute by the addition of one drop of lead tetra-ethyl to 5 c.c. of benzaldehyde. The report of this work has been delayed, but a forthcoming publication by Mr. H. J. L. Bäckström will record in detail work of which this is one phase.

In the meantime we have obtained other results which demonstrate one other possible mechanism of known suppression by lead tetra-ethyl. Charch,

Mack, and Boord have suggested (*Ind. Eng. Chem.*, 18, 336; 1926) that the suppression is to be associated with the liberation of fine particles of the free metal in the gaseous mixture, these atoms functioning as catalysts of oxidation, themselves undergoing rapid oxidation and producing, at a definite stage in the engine cycle, a large number of oxidation centres. A homogeneous combustion throughout the gas mixture ahead of the flame front would thus occur, thereby suppressing the formation of a detonation wave and consequent knock.

Our own experiments on the properties of hydrogen atoms (*Trans. Faraday Soc.*, vol. 21, 1926) have led also to a study of the decomposition of metal alkyls of the lead tetra-ethyl type and to an important addition to the above concept. Not only may the lead atoms function as oxidation centres, but also, and to a very much more marked extent, the free radicals, e.g. C_2H_5 , liberated by the thermal decomposition, are extremely reactive in the presence of hydrocarbon-oxygen mixtures. Complete disappearance of oxygen is secured at temperatures below 300° C. Indeed, with hydrogen atoms, in the presence of ethylene and oxygen, reaction is secured at room temperatures, oxygenated organic compounds being produced. Free radicals, therefore, may function as oxidation centres producing homogeneous combustion, an effect supplementary to the inhibitory action of the metal alkyl on oxidation of the aldehydes produced by partial oxidation of hydrocarbons. The action of the free radicals may well account for the inhibitory effects produced by non-metallic knock suppressors of the type of aniline. As yet, there does not seem to be any method whereby the relative importance of these several possibilities may be estimated.

HUGH S. TAYLOR.

Princeton University,
New Jersey.

A Mawken Canoe in Algoa Bay.

ACCOMPANYING this is a photograph (Fig. 1) of a dug-out canoe which I found washed up on the sea beach in Algoa Bay at a point known as New Brighton. The canoe is 22 feet long, 16 inches in



FIG. 1.

width, and 14 inches deep. It has been hollowed out from a large tree. Towards the stern there is a cavity in the bottom of the canoe for the reception of a mast. The side pieces, which have the appearance of rowlocks, can be clearly seen in the photograph.

Dr. Ernest Schwarz, professor of geology at the

Rhodes University College at Grahamstown, made a careful examination of the canoe, and definitely stated it was not of African origin. He advanced the opinion, confirmed later, that it came from the Mergui Archipelago, which consists of a group of small forest-covered islands in the Bay of Bengal to the north of Sumatra. I have consulted the book entitled "The Sea Gypsies of Malaya," by Mr. Walter Grainge White, which seems to prove that Prof. Schwarz is right. The relic appears to be the hull or base on which a superstructure was built. The so-called rowlocks are evidently for the purpose of receiving slats of wood to form ribs. Along these the sliced stems of palms are bound, and the joints caulked with a resinous gum obtained from the forest trees. On cross pieces of bamboo a deck of split bamboos is laid down, and also caulked. At one end (the stern) a small shelter with a mat cover is erected.

These boats are the floating homes of a primitive race of people known as the Mawken.

Presuming our canoe is of Mawken origin, how came it here, a distance of some 5000 miles from its original home? Was it carried by means of the Malabar ocean current which has its origin in the Bay of Bengal? It is, however, the only relic of its kind which has been recorded from South Africa.

F. W. FITZSIMONS.
(Director.)

Port Elizabeth Museum,
South Africa.

A Mutant in Cotton.

ON the Government Farm at Dharwar, Bombay Presidency, India, I have for several years had under observation pure lines of cottons of several species and varieties. One of these was *Wagale*, a Burmese variety of *Gossypium neglectum* Tod. From 1919 this variety has been self-fertilised, and only the self-fertilised seed used for sowing in each generation, of which there has been one per annum. Like all the Indian cottons, this variety has normally had simple and stellate hairs on stem, petiole, and leaf. The variety bred true for this character of hairiness until 1925, in which season there appeared one plant which was entirely glabrous.

The normal plant has a ginning percentage of about 30, but the hairless plant had no lint at all although its seeds showed the shorter 'fuzz.' The petal length was also shorter than normal, averaging 17 mm. as against the normal 35 mm. This plant was self-fertilised and seeds were produced. In the season of 1926-27 these seeds were sown, giving 80 plants, all showing absolute hairlessness, lack of lint, and short petals. This new type appears to be a genuine mutant. Its behaviour in further generations and in crosses is being studied.

G. L. KOTRUR.
(Cotton Breeder.)

Bombay Agricultural Department,
Dharwar, India, Feb. 19.

The Microscopical Examination of Flint Surfaces.

I AM glad to see my friend Mr. Reid Moir is turning his attention to the surface-structures of fractured and fissured flints (*NATURE*, April 16, p. 560); and I am sure we shall know something more about them before he has done with them. For more than fifty years I have been pointing out some of these, and the differences in their subsequent disposition to metamorphoses. I used to liken them sometimes to bread cut and broken, both in appearance and in their action when we turn them into the soup. The transitional Fawkhmanian implements are splendid examples of these: every man-fractured (or flaked) face is now porcellanised, while the 'natural' facets have been altering ever since.

The question, however, is not quite so simple as it might appear. There are eight factors that enter into the formation of the macro- and micro-surface-structures of free struck (fractured) and thermal fissured flints; these are: (1) the state and its variety to which the particular flint belongs; (2) the exact point the specimen has reached in the collo-crystalline evolution; (3) the degree and kind of metamorphoses the flint has attained; (4) the degree of molecular rearrangement associated with disruption it has reached and which of the various forms of these are present; (5) the support at the moment of fracture (resilient or rigid); (6) the shape of the striking-face; (7) the shape and nature of the striker (hammer); (8) the velocity of the blow.

In addition to these, in the case of thermal fissure, much will, of course, depend upon whether the heat be oxidising or reducing.

W. J. LEWIS ABBOTT.

Fluorescence of Sea Anemones.

I NOTICED recently, upon the rocks in Torbay, a number of sea anemones the tentacles of which appeared to fluoresce in sunlight. The effect is limited to the tentacles, for they appear to have a pinkish-brown colour by transmitted light, which changes to vivid green when viewed by light reflected from their surface. The body of the anemone itself is yellowish-brown and does not appear to fluoresce: nor do the pink tips of the tentacles.

Wishing to confirm the effect, I brought two specimens to London, and on placing them in a beam of ultra-violet light from which the visible radiation was filtered, the brilliance of the green fluorescence was very striking. I would suggest, therefore, that a source of ultra-violet light might be a useful adjunct to marine biological laboratories.

CHARLES E. S. PHILLIPS.

Castle House,
Shooter's Hill, S.E.18.

The Modern 'Zoo.'

ON behalf of the Council of the Zoological Society of Scotland I should like to express to you our great appreciation of the excellent notice in *NATURE* of the Society's appeal for funds for the continued development of the Zoological Park here. The publicity given, through *NATURE*, to our aspirations and our necessities will aid very greatly the effort we are now making, and I thank you most cordially for it.

Perhaps you will permit me to add that if any of your readers would be interested to receive a copy of the illustrated appeal, which contains a fairly full description of the Park, I should be very pleased to send one to any address given me, and if any one should be generous enough to subscribe towards our development fund, I shall be most happy to receive and acknowledge subscriptions.

T. H. GILLESPIE.
(Director-Secretary.)

The Zoological Society of Scotland,
Murrayfield, Edinburgh, W.

The Law of Flame Speeds.

THE quotation by Mr. A. G. White in *NATURE* of May 7, p. 674, is misleading from the context, and we would refer readers to the preceding paragraph in the paper from which the quotation is made (*Jour. Chem. Soc.*, 1919, 115, 1455).

W. PAYMAN.

R. V. WHEELER.

Safety in Mines Research Board,
Sheffield, May 12.

Logic and Law in Biology.¹

By Dr. P. CHALMERS MITCHELL, C.B.E., F.R.S.

TEN years after the publication of the "Origin of Species," Kelvin, then Sir William Thomson, threw a bomb into the camp of the apparently victorious evolutionists. "It was quite certain," he said, "that a great mistake had been made—that British popular geology at the present time was in direct opposition to the principles of Natural Philosophy." According to the great physicist, the rate of cooling of the earth and other physical 'principles' showed that our globe could not have been in a position to support life for longer than a period of from 50 to 300 million years. In his opinion, the drafts on the bank of time demanded by those who upheld uniformitarian geology and the evolution of plants and animals could not be honoured.

Science rebuking science! It was meat and drink to the disheartened supernaturalists, the more reviving because in these days physical science was in good odour, and the new doctrine of evolution was the enemy. Huxley dealt with it in his presidential address to the Geological Society in 1869. He had no difficulty in showing that Kelvin's 'principles' were not unbending laws with universal jurisdiction, but merely combinations of observation, inference, and theory in different proportions. He took his final stand on the simple ground that as there was sufficient evidence for the orderly succession of the rocks and the orderly appearance of fossils in them, there must have been sufficient time for these processes. From this logical viewpoint he reached a remarkable result. Assume the correctness of Kelvin's calculation of the earth's rate of cooling and that yet there is sufficient evidence for evolution having taken place; why then there must be some unknown source of heat in the crust of the earth? Such a source of heat has been discovered in the radio-active elements, and from the rate of their disintegration the age of the oldest sedimentary rocks has been calculated at 1200 millions of years—a credit at the bank of time ample to meet all cheques presented by the followers of Lyell and Darwin. Twenty years later, in the course of an amusing controversy with the Duke of Argyll and a brace of bishops who had been talking about the suspension of 'lower laws' by 'higher laws,' as when a man raised a stone in his arm, he discussed the meaning of the term 'law' in science. He insisted that it was no more than the product of a mental operation upon the facts of Nature which had come under observation. It had no external existence and included no conception of causality. He took as examples the Newtonian laws of gravity and of motion and the law of constancy of mass.

At the time, Newton's laws must have seemed as securely established for the whole universe as any principle of science, and the constancy of mass

through all chemical changes appeared to be a foundation of chemistry. With regard to both, Huxley insisted that they had no necessary sway. He stated the laws as to gravitation in such terms that they require not a word of alteration now that Einstein's unexpected discoveries have been made and confirmed. With regard to the constancy of mass he went even further, and said that there was no reason in our knowledge of the facts why mass should not be found to alter with the conditions. Recent physics have shown that in the atomic system the mass of the electron is a function of its rate of motion.

If, as Sir Oliver Lodge believes, the disincarnated spirit of Huxley is still in conscious existence, there must be a wry grin on what corresponds with the face of a disincarnated spirit, if Huxley imagines that I am going to claim prophetic powers for him on the grounds that he anticipated the discovery of radio-activity, made allowances for Einstein's amendments of Newton, and foresaw the gyrations of the electron. Huxley laid no claim to any faculties not within the scope and the duty of every man of science. His mental discipline comprised accurate observation, clear statement, the most rigid scrutiny of generalisations, the withholding from these generalisations of any iota of causal principle or any right to application to sets of facts different from those upon which they were based, and, above all, the declaration of ignorance in preference to the invention of imaginary principles. If, as he believed, the writ of science is to run howsoever it may be in opposition to customs, traditions, beliefs, or dogmas, there is the more need for scientific men to distinguish carefully in their pronouncements, especially to the public, between generalisations well founded on observation, probabilities, possibilities, and hopes.

The presidential address to the British Association at Liverpool in 1870 is a conspicuous example of Huxley's methods. He described simple facts of everyday life, such as the appearance of maggots in carcasses, of moulds on fruit, of vinegar eels, and so forth, explained by the ancients as due to spontaneous generation of the living companions of corruption from the corrupting but dead matter. In 1568, Redi, the Italian, covered meat with gauze, watched the blowflies, attracted by the smell of putrefaction, settling on the gauze, but noted that as the eggs could not pass through the gauze no maggots appeared in the meat. From similar experiments Redi drew the generalisation that living organisms arose in nutrient media only when the living seeds of these organisms had previously gained access to the media. The gauze of Redi has now been replaced by the far more delicate methods of bacteriologists, and the generalisation has been extended to almost every kind of living thing with which we are acquainted. But the principle remains the same; such 'causa-

¹ From the Huxley Memorial lecture delivered at the Imperial College of Science and Technology, South Kensington, on May 4.

tion' as there may be lies in the meshes of the gauze or their equivalent, not in any absolute distinction between living things and inorganic matter. To this generalisation Huxley gave the name 'biogenesis'; to the opposite conception, that of the direct origin of living from dead or inorganic matter, he gave the name 'abiogenesis.' As if foreseeing how his statement might be abused, consciously or unconsciously, he went on to say in a memorable passage that, so far from seeing in biogenesis a necessary and absolute principle, it was his expectation—belief was too strong a word in the absence of evidence—that a spectator in far-distant geological times might have seen the actual origin of living matter from inorganic matter. His prevision was necessary. In a recent book, addressed to the wide public, Sir Oliver Lodge has said that the "doctrine of biogenesis is that life could alone produce life." In another recent book, addressed to a narrower circle, Prof. Lloyd Morgan, setting out from the article on biology in the 11th edition of the "Encyclopædia Britannica," says that the authors implied that "biological events are not susceptible of interpretation in terms of physics and chemistry." The authors said nothing of the kind. They wrote, "have not been interpreted." Advocacy of the supernatural in natural science seems to confer an obliquity of vision.

My object is now to pass in rapid review some of the history of biology before Huxley and since Huxley, and to show how with a monotonous reiteration the craving for final causes has led many great biologists to extend their generalisations beyond their scope and to impose on them imaginary principles; in short, to invent gods and to place them in the machine to account for the part of the working not yet understood.

What is the order of events in the development of a new individual? Two eggs, similar in size and appearance, placed in an aquarium tank under the same conditions, grow, the one say into a mollusc and the other into a fish. In the words of Bateson, whose premature death removed from us one of the most active and productive workers in the long history of our science, "Shakespeare once existed as a speck of protoplasm not so big as a small pin's head. To this nothing was added that would not equally well have served to build up a baboon or a rat." I do not accept these crude statements without qualifications so great as to reduce them almost to nonsense, but they serve well to pose the main problem of biology, the likeness of offspring to parent. To biologists of the seventeenth and eighteenth centuries the answer was easy. Recall their pictures of the egg with the miniature of a human being coiled up within it. They believed that the process of development was the evolution or unrolling of a preformed minute adult, invisible to us only because of the imperfection of our optical appliances and the opacity of the medium. The English Harvey and some others were uneasy about this interpretation, but it was not displaced until Caspar Wolff in 1759 published the results of his

observations on the development of the chick. Wolff was able to show that the germ was unformed material and that it assumed only gradually, stage by stage, the likeness of its parent.

Development is an epigenesis, the putting on of phase after phase. Wolff saw that the preformation theory was miraculous, differing, as he put it, only from ordinary miracles inasmuch as it had been performed once for all by the Creator at the beginning of the world. But having got rid of miracle in one way he introduced it in another. For he endowed his plastic organic material with a *vis essentialis*, an inherent force by which it wrought its own miracle. Wolff thus by actual observation freed biology from the chains of a preconception and set embryology on lines which have led to great advances in knowledge. But the theory he imposed on his observations has been the parent of a great brood, a whole Valhalla of false gods; hear the names of some of them: vital force, *nisus formativus*, bathmism, enteleche, creative evolution, emergent evolution, purposive striving—not one of them more than a beguiling word for ignorance.

After nearly two centuries rich in new knowledge of the observed facts of embryology, but with no important advance in theory, there came August Weismann. A skilled embryologist, he knew the successive phases of development to be a visible epigenesis and to recall at least in a general fashion the ancestral history. The fertilised egg-cell of a human being recalled the morphological grade of the protozoa, next assumed (as Huxley was the first to recognise) the appearance of the coelenterate or two-layered creatures, then became a simple coelomate, then a generalised chordate which might be about to become fish, flesh, or fowl, then an anthropoid stage man or ape, and only at a very late prenatal stage assumed definitely its human structure.

But Weismann found an exception to this orderly epigenetic progression. The cells which were going to become the gonad of the future adult did not wait to appear in their turn in their due order and place. They were separated, usually, if not invariably, at an extremely early stage, and preserving their individuality, were passed along through the developing embryo, occupying now one position, now another, until they reached their final place. The likeness between parent and offspring was thus shown to have a material basis and the link between ontogeny was given a local habitation and also a name, the germplasm. The daughter was only a delayed sister of her mother. Neglecting the complications due to parental crossing, the mother and daughter were products of the same germplasm.

With regard to the development of the individual, however, Weismann's endowment of the germplasm with a historic architecture was a return to a more subtle kind of preformation. The bricks of his imagined edifice were 'determinants,' separate particles so arranged as to be given off at precisely the time when they were required to control the

development of the tissues into which they were marshalled. The initial stock of germplasm was thus disintegrated into sets of determinants with limited powers of control until each portion reached its final stage of being able to determine only one kind of cell or tissue. The plasm in these various stages of irreversible disintegration was what he called the somatoplasm. His interpretation brought into clear light the relative if not the absolute stability of the germplasm, found and stressed the material link between ontogeny and phylogeny. But his historic architecture and his determinants were imagined principles to give causal explanations of processes which were not yet understood.

Oscar Hertwig, a very able experimental embryologist, very soon showed that the stresses of the environment acting on adult and embryonic stages could overpower the control assigned to the historic architecture and compel reluctant material into forms which it would not otherwise have assumed. The irreversible disintegration of the germplasm could not account for the facts, and the accessory theories produced by Weismann and his followers were more ingenious than convincing. Hertwig's insistence on the moulding forces of the environment brought the fresh air of observation of facts into the study of embryology and opened up a new and fertile chapter. But he, too, had to invent a causal principle; the name of the god he placed in the machine was the control of the whole organism over its parts in such a fashion that they served the needs of the whole. It is a disconcerting circumstance that his deity is more powerful in the embryo than in the adult, and in the lower than in the higher organisms.

Making the large allowances necessary for the play of the environment in producing the characters of an organism, there remains much which must be assigned to the hereditary material. The Mendelian analysis of heredity and the physiological doctrine of hormones have found a material interpretation for some of the unexplained occurrences for which Weismann invented his historic architecture and Hertwig his 'control of the whole.' The brilliant experimental analysis of the Mendelians has shown that at least with regard to a certain number of characters, heredity is particulate, consisting of unit characters which may be combined in groups in various ways. There is, in short, a mechanism in heredity which is being explored, and converging advances in knowledge of the nuclear changes are finding a material seat for it. On the other hand, the rejection of the influence of the environment is leading Mendelians into fantastic extravagance. The pronouncement by Bateson, in his address as president of the British Association in Melbourne in 1914, was a return to a conception of preformation more miraculous than those of pre-scientific philosophers. Arguing from the success of Mendelian breeders in eliminating factors and their failure in their efforts to add factors, he suggested a similar limitation for Nature, and that the whole

course of divergent evolution from the beginning of life to the appearance of Shakespeare had come about by the elimination of factors.

The discovery by Brown-Sequard and D'Arsonval of secretions discharged into the blood stream by glands in addition to the secretions liberated through their ducts, and their extension of this to the supposition that all organs and tissues might produce internal secretions, have been carried much further by more recent work. It has been shown that many of these secretions, called hormones, or chemical messengers, by Bayliss, Starling, and W. B. Hardy, do exist and exercise highly specialised co-ordinating functions. They form a chemical nexus independent of nerve reflexes, and so far definitely reduce the unknown field for which Hertwig invented his mysterious power of control by the whole over the part. Experiments particularly on the development of batrachian larvæ have shown that secretions produced at one stage of the development control the later stages. It may be that in hormones will be found to be the material agents by which the germplasm controls the development of the individual. But those which have been studied so far are extremely precise in their action, and I have been unable to find a trace of direct evidence for the belief so greedily imbibed by those who accept the evidence of the inheritance of acquired characters—the belief, for example, that if the plumage of a bird or the coloration of a moth becomes darker from the effect of some agent in the environment, the melanistic tissues will produce a changed hormone of such a kind that it will influence the germplasm to produce melanistic forms.

To what general issue have I led myself in this rapid review of some biological problems in the light of Huxley's canons? Definitely to the position that if we scrutinise our generalisations and do not extend them to a class of facts from which they were not derived, if we do not endow abstractions with an independent reality, we shall find no logical ground to infer the existence of any but physical events in the world of living things. I agree that the phenomena of living things have not yet been fully interpreted in terms of the inorganic. But I note that every positive addition to biological knowledge in the last century, from the identification of Mendelian factors in heredity, the artificial fertilisation of ova and the other achievements of bio-chemistry, to Sir Charles Sherrington's exploration of mammalian reflexes, has been a diminution of the residuum to which it is possible to apply vitalistic conceptions. On the other hand, Philosophy, since she was judicially separated from science, has made no positive addition to knowledge. How far our progress will go, I do not know. It may only be a phase of anthropomorphism to expect that man can ever comprehend the universe. But science must pursue the quest, and if we adhere to what is called materialism in the simplest sense of the word, we shall at least in the future, as in the past, make positive additions to knowledge.

Some Properties of Coke.¹

By Prof. J. W. COBB.

COKE is formed when coal, heated out of contact with open air, softens and is blown into a porous mass by its own gaseous products of decomposition. The structure of the coke is determined by a number of circumstances, but the relation between the softening and the evolution of gaseous products of decomposition is all-important.

In the structure of charcoal the original structure of the wood carbonised is, to a considerable extent, retained in the resulting charcoal. The annual rings, marked by a difference in size in the cells, are to be seen quite plainly. In a coke made from a bituminous coal, the original solid structure has disappeared, and has been replaced by a porous honeycombed mass.

It is not every coal which undergoes coking. Anthracite, for example, does not soften or coke. The coking property has been associated chemically with the existence in the coal of substances which can be extracted from it by suitable treatment with solvents, but the interpretation of the results is controversial.

If the various factors are considered, it is not strange to find that the characteristics of a coke made from the same coal under different conditions are themselves very different. This consideration has even greater weight if one visualises the further complication of coke formation as it exists on the large scale, say, in a continuous vertical gas retort. The upper part of such a retort may be quite cool, gases escaping at, say, a temperature of about 100° C. Such an apparatus necessarily acts, to some extent, as a reflux condenser; some of the tarry products of decomposition from the lower and hotter parts of the retort will be recondensed around the cooler particles near the top, so that the descending coal charge is moistened by this film of condensate. If the film evaporates without decomposition a little lower in the retort, it will have produced a caking effect while it was wet and sticky but will have no ultimate coking effect. If it decomposes leaving a cementing residue, the coke will be the stronger for it. At high temperatures such a cementing action can also be exercised by the decomposition of such a gas as methane. Similar considerations apply to the coke oven.

It is for reasons such as these that the type of large scale apparatus used in carbonisation, its method of use, and the preparation of the coal as affecting the penetration of heat to the charge, and the facility of escape of products of carbonisation, become of nearly the same importance as the original character of the coal in determining the character of the coke made from it.

WATER-GAS.

One of the most important properties of coke industrially is its interaction with steam, producing

water-gas—a mixture of carbon monoxide, hydrogen, carbon dioxide, with some undecomposed steam. This is made not only in the water-gas process proper, where coke is blown alternately with a current of air and with steam, but also in the gasification of coal in a gas producer which is blown with a mixture of air and steam, and again to some extent in the making of town gas, when some steam is blown into the bottom of the retort—the so-called steaming process.

ASH CONSTITUENTS.

It was suggested by Haber many years ago in his "Technical Gas Reactions" (1903) that a constituent of the ash of the coke used in the water-gas process might stimulate reaction. We have gone further into this matter, being led to do so partly from a desire to obtain specific and quantitative information on that subject, and partly because we were specially interested in the behaviour of the nitrogen and sulphur compounds in coke where the ash constituents were known in some cases to exercise an important influence. For this purpose we prepared special cokes at 500° and 800° C. from coal with which had been incorporated 5 per cent. of such oxides as silica, alumina, lime, and ferric oxide, or equivalent quantities of other compounds, such as sodium carbonate. Since the original coal had been carefully chosen as containing only 1 per cent. ash, it would be reasonably hoped in this way to obtain an idea of the influence of each of the common ash constituents of coal in turn.

That the ash constituents were going to exercise some influence was obvious from the first trials of these mixtures made in an ordinary crucible test. The original coal when so heated gave coke buttons swollen and honeycombed. The iron oxide and sodium carbonate cokes were close-grained and uniformly porous, while the sodium hydrate mixture gave a barely coherent powder. Dr. Lessing, who had worked previously on the influence of catalysts on the carbonisation of coal, had claimed an influence on the character and yield of coke from this cause.

When we came to examine cokes prepared at 500° and 800° C., the results were suggestive. Considering the cokes prepared at 500° C., the presence of iron oxide and sodium carbonate altered the proportion of residual volatile matter. These cokes also differed in structure from the pure coke, being of a much closer and more evenly porous texture. This result would suggest that, whatever the ultimate explanation may be, the action of oxide of iron is to delay or modify the decomposition below 500° C., lessening the evolution of volatile matter from the softened coal and the consequent puffing-up of the mass. At a later stage, below 800° C. apparently, this volatile matter was evolved, but it was presumably then without effect on the structure because solidification had by that time occurred.

¹ Substance of two lectures delivered at the Royal Institution on Mar. 29 and April 5.

SPECIAL COKES IN STEAM.

We passed on to an examination of the comparative behaviour of these cokes when treated with steam at 1000° C. Marked differences between the cokes now appeared. The lime coke was plainly much more reactive than the pure coke, the iron oxide coke more reactive again, while the rate of steaming with sodium carbonate coke had to be pushed very high before there was any appreciable falling away from complete decomposition. Moreover, the composition of the gas attained was different. At a rate of 10 litres an hour, taking extremes, with the pure coke 61 per cent. of the steam was decomposed, and the water-gas contained 9.2 per cent. carbon dioxide, while the sodium carbonate coke had decomposed 98 per cent. of the steam, giving a water-gas containing only 0.4 per cent. carbon dioxide. It was interesting to speculate whether this difference in behaviour was a specific chemical effect due to the presence of these special constituents in the coke, or whether it was due mainly to the difference in physical structure which we knew had been brought about in the cokes during the preliminary process of carbonisation.

The tendency of opinion for some time has been to attach primary importance to the physical structure of coke as influencing its reactivity, and there seems to be no doubt that it is an important factor. It has, however, been demonstrated by impregnating the 'pure' coke with sodium carbonate (soaking in a solution and drying), that practically the same enhanced reactivity can be brought about in that way as by mixing with sodium carbonate before carbonisation, which eliminates the altered physical structure as playing the principal part in the enhancement of reactivity in this case. The results at lower temperatures were equally striking, a very noticeable feature being the low carbon dioxide content of the gas made by steaming sodium carbonate coke at 800° C.

REACTIVITY IN CARBON DIOXIDE AND AIR.

Reactivity to carbon dioxide is probably most important of all and was next examined. The formation of carbon monoxide from carbon dioxide is at the root of the manufacture of producer gas by blowing air through a deep column of coal or coke, is all-important to the working of the blast furnace, and plays its part in every coal or coke fire.

Lower temperatures were used than with steam, because of the higher reactivities. 1 per cent. of oxide of iron was found to give more than half the enhanced effect which came from 5 per cent. An impregnated sodium carbonate coke was proved to be almost as active as one prepared by adding the sodium carbonate before carbonisation. With some of the special cokes, and more particularly the sodium carbonate coke, there was a falling off in reactivity as an experiment proceeded. An interesting observation made on the oxide of iron coke, which is likely to be of theoretical importance,

suggests that reduced iron may be present and taking part in the cycle of reactions.

It is difficult to test for differences between cokes as to their reactivity with air at temperatures above the ignition point. This is largely owing to the experiment getting out of hand on account of rise in temperature when air or oxygen is used. We have made some attempts by limiting the heating effect in two ways, by using air diluted with nitrogen until it only contained 2 per cent. to 3 per cent. oxygen, and by leading it over a small flat surface of coke with a limited surface of 1 cm. square. Measurement showed that by this method it was possible to obtain combustion without accumulation of heat or rise in temperature.

In these experiments the behaviour of all the cokes was practically the same above 700° C., but at lower temperatures— 400° to 600° C.—wide differences appeared. The opinion previously put forward is thus confirmed that at high temperatures the reactivity of cokes in general is so high in air that differences in behaviour depend upon the rate of supply of air to the coke particles rather than on the reactivity of the cokes. One remarkable feature noticed in these experiments was the apparent slowness with which the highly reactive sodium carbonate coke began to react with oxygen. The same phenomenon had been noticed in experiments on the temperature of ignition of the special cokes.

HEATING OF COKE IN AIR.

When air is passed through hot cokes differing in their degree of reactivity, the result obtained appears, at first sight, somewhat anomalous. In each case there is an effect due to the burning of coke to carbon dioxide on first contact, and while the air is in excess. Heat is generated, and if the air supply is the same for each of two cokes, the same heat will be generated by this primary reaction in each case. There follows, however, the further interaction between carbon dioxide and carbon, reducing some of the carbon dioxide to carbon monoxide, and the degree to which this action is carried on is greater the more reactive the coke. It is with respect to this second reaction that cokes differ so much.

Now one characteristic of the conversion of carbon dioxide to carbon monoxide by carbon is that it absorbs heat. The net result is that the difference between the two cokes shows itself in the difference of the cooling effect, and it is with the more reactive coke that the cooling effect is more pronounced. Hence, in blowing air into hot cokes, it is the less reactive coke which generates heat most quickly in the mass.

A comparison of this property has been effected on the laboratory scale. 10 gm. of coke was placed in a vertical, electrically heated furnace. A thermocouple was inserted from the bottom end of the furnace tube in such a way that the junction was 2 cm. distant from the upper surface of the coke. The furnace was then heated up to 700° C. and maintained at that temperature for one hour, after which the heating current passing through

the furnace was left unchanged throughout the remainder of the experiment, and air was passed down the coke column at the rate of 50 litres an hour. The results obtained for three cokes named in the order of their reactivity to carbon dioxide—sodium carbonate coke, 'pure' coke, and beehive oven coke—indicate that the highest temperature effect in the interior of the mass has been attained with the least reactive coke for the reason explained, doubtless an important point in high-temperature melting by coke.

INDUSTRIAL AND DOMESTIC APPLICATIONS.

I should like now to say a few words on the influence of some properties of coke (particularly reactivity) when used for various purposes. The simplest case is perhaps that of the gas producer, in which coal is gasified by blowing with air or a mixture of air and steam. There is a first conversion of carbon to carbon dioxide by air quite near the grate of the producer at the bottom, but after that the gasification of the descending carbon is the result of the conversion of carbon dioxide to carbon monoxide by the reaction $C + CO_2 = 2CO$. The efficiency and rapid working of the producer depends upon this reaction, so that the coke which is more reactive to carbon dioxide is, other things being equal, the best for the process. This is a reproduction on the large scale of the laboratory experiment last described.

Another interesting example is the domestic fire, where so much depends on the relative ease of ignition and the rapid spreading of heat through the body of the fire. With a hard and unreactive coke it is difficult to carry the heat forward from piece to piece. If there is a little volatile matter left in the coke which comes away in flames, the heat transference is much more rapid. Or, if the coke for any reason is more reactive, the same advantages obtain. There are, however, limitations to the advantages obtainable in either of these ways. If the amount of volatile matter is too great, or if too much carbon monoxide is produced by excessive reactivity of the coke, there may be a twofold loss. In the first place, these gases may screen the solid coke from oxygen and so prevent that rise of temperature on the surface which is all important if a cheerful fire is to be obtained, or if the fire is to have a high radiant

efficiency. The other detrimental effect is more important and depends upon the following phenomenon.

A bunsen flame burning in the open radiates only about 10 per cent. to 15 per cent. of its total heat of combustion, or rather more if the flame is luminous. If, however, the flame is used as in a modern gas-fire, to heat a solid radiating surface, the proportion radiated comes up to somewhere about 50 per cent. Consequently, in a coke fire, that portion of the combustion which is raising the temperature of the solid coke surface is being very much more efficiently utilised than in combustion of flames from the top of the fire burning in the open. Thus one may take it that if the amount of gas evolved is relatively small, so that it can burn in the fire, raising the temperature of the radiating surface of coke, it is very effective. But larger quantities of gas burning from the top of the fire are comparatively inefficient.

In experiments made at Leeds on the same fire, burning different solid fuels, this phenomenon was much in evidence on measuring the radiant efficiencies obtained from the fires. The experiments require extension, but I may say that the results were in accordance with the foregoing considerations, and agreed substantially with those of Dr. Margaret Fishenden of the Fuel Research Board, in that coke was found to give a higher radiant efficiency than coal. One striking result obtained, however, pointed to the necessity of not having present in the coal, ash of such a quantity and kind as to form a coherent coating during the burning, which thus formed a screen around the burning material and lowered its radiant efficiency.

Another very interesting point was the behaviour of a coke soaked in sodium carbonate solution, and therefore very reactive. It burned very freely, with visible flames a foot long. In appearance it was attractive. As a matter of fact, its radiant efficiency was not so high as that of the medium temperature coke, and that for the reason that I have explained. It reacted freely, generated carbon monoxide in quantity, the carbon monoxide burned with long flames at the top of the fire, and its radiant efficiency was correspondingly low—a defect due to the high reactivity of the coke.

Obituary.

PROF. A. A. LAWSON.

IT is little more than a month since the formal opening of the new Botanical Department in the University of Sydney was described in *NATURE*, with an illustration given of the building itself (April 2, p. 509). Before those who read it were able to formulate, much less to convey to Prof. Lawson their congratulations on this tangible mark of his successful tenure of his chair, he was in his grave, in the South Head Cemetery that looks out seawards over the entrance to Sydney Harbour. His death, following closely on a serious operation from the effects of which he never rallied, took place on Mar. 26 at Sydney.

Abercrombie Anstruther Lawson was born in Fife, and entered the University of Glasgow as a medical student. After passing through the course in elementary botany, where his artistic skill had already attracted attention, for reasons of health he went to California, and entered the University of Berkeley, coming under the influence of such teachers as Setchell and Osterhout. Graduating as Master of Science in 1898, he became instructor in botany, having already entered on a career of research. He also studied later in Chicago and at Bonn, with published results which led to his appointment as lecturer in his old University of Glasgow in 1907. Having held this position for

five years, he was appointed to the chair of botany in Sydney, where he not only secured the erection of a new Institute, the opening of which took place on Nov. 6, 1926, but he also built up a school of botany, with a large and growing body of students, and a highly creditable list of published researches.

Lawson's own published work falls into three groups, relating respectively to cytology, to the gametophyte of Gymnosperms, and to that of the Psilotaceæ. The first memoir on the pollen mother-cells of *Cobæa* formed the thesis for his degree. Already that delicacy of pencil craft was revealed which marks all his later work. Few microscopists have combined more effectively than he did refined cytological method with artistic skill. This was the first of a series of memoirs relating chiefly to meiosis, which were continued until 1912. They are characterised rather by faithful record of detail than by the establishment of new points of view. Armed thus with exact laboratory experience, he carried through a long series of observations of the gametophyte and propagative processes in the gymnosperms. These will stand as a permanent record of patient research, by an observer of high technical skill. They opened while he was still instructor at Berkeley: they were continued during the period of office in Glasgow, and later in Australia, where they related chiefly to local genera, such as *Microcachrys* and *Pherosphaera*. The last of this series was a particularly fine memoir on *Bowenia*, published in 1926, with eight plates (*Trans. Roy. Soc. Edin.*, vol. 54). At the time of his death, a further memoir on *Macrozamia* was already well advanced. His illustrations from the earlier of his memoirs on the Gymnosperms have been very widely absorbed into Lotsy's "*Stammes-Geschichte*," vol. 3. No one can in the future treat the Gymnosperms generally without frequent reference to the wide observational work of Lawson.

Lawson left his mark also in a third line of inquiry: in 1917 two memoirs appeared on the gametophytes of *Psilotum* and *Tmesipteris*, so long awaiting discovery. It is true that the ground has since been covered in greater detail for the latter by Holloway, and in particular in the embryology: but that need not detract from the exact delineation and description given of their gametophytes. Lawson had also wide interest in the Algæ. He had collected with Setchell on the Aleutian Islands and on the coast of California. He made a special journey to collect them on the Jamaican coast, and he was well posted in the British marine Algæ. But he appears never to have published upon them.

While it must be conceded that Lawson's work has been detailed and analytical rather than constructive, we should bear in mind that he was still a comparatively young man, and that the last twelve years have been devoted to the establishment and consolidation of a school of botany in Sydney. As they stand, his numerous memoirs have added substantially to the sum of positive knowledge. They may not have formed new patterns in the web of the science, but they have filled many of its blanks, not only with artistic effect, but also with honest and trustworthy

records. It will be a pleasure to his friends to remember that the Royal Society of Edinburgh recognised the merit of his work, so largely published in its *Transactions*, by the award of the Makdougall-Brisbane Prize. A deeper satisfaction will be felt in the fact that the inclusion of his name in the recent list of selected candidates for fellowship of the Royal Society was published in time for him to have been aware of this high distinction, and to receive the congratulations of his many friends in Australia, though his death has occurred before the date of formal election. F. O. B.

PROF. ADOLF MIETHE.

PHOTOGRAPHIC science has suffered a great loss in the death, on May 5, of Regierungsrat Dr. Adolf Miethe, professor at the Technische Hochschule in Berlin-Charlottenburg. Prof. Miethe was born in Potsdam on April 25, 1862, and studied physics, astronomy, and chemistry in Berlin and Göttingen. After working with Prof. Hartnack in Potsdam, and then with Schulze and Bartels in Rathenow, he became director of Voigtländer und Sohn in Braunschweig, leaving this position in 1899 to become professor at Charlottenburg as successor to H. W. Vogel, the discoverer of the sensitising action of dyes on the photographic emulsion. According to the *Photographische Industrie*, Miethe was responsible for the teaching of scientific and practical photography in all its branches, photo-mechanical methods, spectral analysis, optics, and astronomy. He was also well versed in botany, mineralogy, and other subjects.

Miethe was the first to construct anastigmats, the name of which is due to him. He improved opera and field glasses, invented, with Gaedicke, magnesium flashlight photography, and introduced the isocyanine dyes as optical sensitisers for the photographic emulsion. It was due to his efforts that great advances were made in the three-colour collotype process. During the last year or two Miethe's name has been brought more prominently into general notice by his claim to have transformed mercury into gold, a claim which, however, has not been satisfactorily substantiated.

Miethe was prolific as a writer and was very successful in presenting scientific knowledge in such a form that it was readily understood by the general reader. Several books dealing with photographic subjects came from his pen.

WE regret to announce the following deaths:

Mr. J. Barnard, formerly senior mathematical master at Christ's Hospital, both in London and after its removal to Horsham, aged seventy-six years.

Sir Sidney Colvin, formerly Slade professor and director of the Fitzwilliam Museum, Cambridge, and keeper of prints and drawings at the British Museum, on May 11, aged eighty-one years.

Dr. Maurice F. FitzGerald, emeritus professor of civil engineering in Queen's College, Belfast, on May 4, aged seventy-six years.

Prof. J. S. Nicholson, until recently professor of political economy in the University of Edinburgh, on May 11, aged seventy-six years.

News and Views.

THE first Conference representative of the Governments of the British Colonial Empire was opened in London by Mr. Amery, Secretary of State for the Colonies, on May 11. The speech in which Mr. Amery welcomed the delegates followed closely the lines of his address to the members of the Imperial Conference held last year. He dealt with the extent, resources, and trade of British undeveloped tropical and sub-tropical estates, and the diversity of problems, constitutional, economic, and cultural, and of the interest of every part of the Empire—including the self-governing Dominions—in the solution of those problems. There is, however, as he pointed out, very little structural or administrative unity to correspond with the unity of the problems and of the spirit in which they are approached. While the lack of co-ordination between the various parts of the Colonial Empire, their almost complete autonomy and self-sufficiency as regards their essential services is not altogether disadvantageous, yet it militates against the efficiency of those aspects of administration into which scientific method and scientific research enter, problems of agriculture, of veterinary science, of health, and of transport. In all these matters much closer co-operation and more effective interchange of information and ideas is needed, particularly of the trained and skilled personnel, who are the most effective agencies for the distribution and dissemination of such information and ideas. But, except for scientific research, Mr. Amery does not envisage a reconstruction of the services into large, all-embracing federal schemes, as he believes the end in view can be attained by the development of a system of consultation by conference.

WHILE not suggesting any marked departure from existing practice in connexion with the technical services, Mr. Amery advanced the view that the prosecution of scientific research is of such vital importance to the whole Empire that it can no longer be left to local governments to determine. The scientific worker must be given a career, a career in which the field of work is just as important as monetary reward; and it so happens that the Colonies which offer the greatest opportunities for research, the development of which is most dependent on the results of research, are the ones which can least afford to offer the salary or the career which will attract the best men. Moreover, it may be that the problems of research of importance to a particular Colony could be best solved in universities or higher research institutions; or the results obtained in one Colony may have almost universal application. Some of the Crown Colonies are now sufficiently aware of this fact to have made the suggestion that a Colonial Scientific Service should be created, a proposition which it is interesting to note was made twenty-five years ago by the Federated Malay States. If the official representatives of the various colonial governments are prepared to agree with the principle of a unified scientific service, at any rate in the higher

re-search grades of scientific and technical work, they should be able, before they separate, to agree also on the means by which such a service could be made effective. The trouble is, however, that very few of the representatives at the Colonial Conference have much idea of what is meant by scientific research. They either expect far too much in return for expenditure on re-search or they are contemptuous of the whole subject.

THE new Electricity (Supply) Act has come into operation and the first scheme prepared by the Electricity Commissioners has been published (London: H.M. Stationery Office. 1s. net. Supplementary Particulars. 2s. 6d. net). It has been presented to the Central Board, and those interested will have opportunities of discussing it. The area selected covers most of the Scottish industrial area and includes Glasgow, Edinburgh, Dundee, and Dumbarton. Like most other engineering schemes it was necessary for the Commissioners to make estimates of the probable demand many years ahead, and we think that they have not been unduly sanguine. They have assumed that the output in Britain will double in about every eight years, and that at the end of 1941 about 450 units per head of the population will be consumed. This agrees fairly well with the 500 units given in the Weir report. Nearly 5000 square miles in central Scotland are covered by the scheme. Ten of the present generating stations have been selected as approved stations, but only six are definitely permanent. The ultimate fate of the other four depends on whether their directors are convinced that it is for their own good and the good of the main scheme that they should give up their status as selected stations. A heavy item in the cost is due to standardising the frequency of the alternating current supply. In the case of the Glasgow and Clyde Valley systems the gross cost of standardisation is estimated at about three and a half million pounds. If we are to get the full benefit of a national scheme, however, it is advisable to standardise at the earliest possible moment. The standard voltage for the 'grid' transmission network has been fixed at 132,000 volts, and the secondary transmission lines will operate at 33,000 volts. The power to be transmitted by a main line is not to be less than 50,000 kilowatts. Ring mains will be used, so that in the event of a breakdown at one point of supply the transmission at all the other points of supply is unaffected. The scheme seems to have been well thought out and should prove to be satisfactory.

THE regretted death of Prof. A. A. Lawson, who was recommended for election into the Royal Society this year, left a vacancy in the number of new fellows, and this was filled by the election on May 12 of George Claridge Druce, M.A. (Oxon), D.Sc., Hon. LL.D. (St. Andrews), Fielding Curator in the University of Oxford. Dr. Druce is distinguished for his numerous contributions to systematic botany, and for his series of County floras (Oxfordshire, Berkshire,

Northamptonshire, Zetlandia, West Ross-shire, &c.). He has discovered and described numerous plants, many of which bear his name. The Fielding Herbarium at Oxford owes much of its present importance to his devoted (and all but honorary) curatorship. He has rendered national service in stimulating and practically promoting the study of field botany among all classes of the community.

THE two hundredth and twentieth anniversary of the birth of Carl Linnæus, the naturalist,¹ occurs on May 23. Born in 1707 at Råshult, in Sweden, he died on Jan. 10, 1778. His father, the rector of the parish, sent his son in the first instance to the University of Lund; afterwards he entered the University of Upsala to study medicine. When twenty-five years old, the Royal Academy of Sciences of that city encouraged Linnæus to make a journey to Lapland in the interests of natural science. At an early age he completed many important works. For example, there appeared his "Systema Naturæ" (1735), "Flora Laponica" (1737), and "Genera Plantarum" (1737). As is well known, Linnæus' extensive collections of plants, insects, shells, and minerals, as well as his library and numerous precious manuscripts, passed into the keeping of the Linnean Society of London. In 1753, Gustavus, King of Sweden, created him a Knight of the Polar Star. By royal command a profile model in wax of Linnæus was made by Inlander in 1773. In this appears a sprig of the flowering plant *Linnæa borealis*. It is interesting in this connexion to mention that in a minute book of the Linnean Society, under date June 2, 1795, this little plant is recorded as discovered for the first time in Britain by Prof. James Beattie, of Marischal College, Aberdeen, in an old fir wood at Mearns, near Aberdeen.

THE Physiological Society celebrated its jubilee by a dinner at the Hotel Metropole on Friday, May 13. The Society was founded in 1876, and its jubilee was in 1926, but owing to the amount of business resulting from the purchase of the *Journal of Physiology* from Mrs. Langley, it was not possible to arrange for the celebration in that year. The four surviving original members of the Society are: Sir David Ferrier, Sir E. Ray Lankester, Sir W. Thiselton-Dyer, and Sir E. Sharpey-Schafer, who presided at the dinner. The toast of the Society was proposed by Major Elliot, Parliamentary Under-Secretary for Health for Scotland, who pointed out the practical benefits that had been obtained as the result of physiological research. The chairman, Sir E. Sharpey-Schafer, in his reply, described how the Society was founded as a dining club to defend the members against the attacks of the anti-vivisection societies, and it thus represented the only good that had resulted from the anti-vivisection agitation. Later in the history of the Society it became customary to visit one laboratory or another before the dinner, to see demonstrations of work in progress. The development of the Society is shown by the present practice, namely, that demonstrations have precedence over other communications, and that all business, except that of a special general meeting

summoned for some specific purpose, is transacted after the dinner which is held with most meetings of the Society.

SIR CHARLES SHERRINGTON proposed the toast of the guests, with which was associated the names of Sir Ernest Rutherford, Prof. G. Fano, of Rome, Prof. Gley, of Paris, and Viscount Knutsford. Sir Ernest Rutherford pointed out the relation between physics and physiology, in which a physical instrument was perfected for some special recording device such as the Einthoven string galvanometer, and was afterwards used in physical laboratories because of its delicacy and accuracy. He recommended a training in physics as a preliminary to research in physiology. Prof. Fano made a delightful congratulatory speech in English, and Prof. Gley conveyed the best wishes of his French colleagues in a stirring address in French. Viscount Knutsford referred particularly to the gain to humanity by Schafer's method of artificial respiration, and to the Research Defence Society, which does its best to educate the intelligent public as to the benefits obtained from experiments on animals. He suggested that physiologists ought to do their share by joining that Society, by furnishing accurate information, and by speaking on the subject. Pro. Leonard Hill proposed a vote of thanks to the chairman, who, he pointed out, had sent apostles to Ireland, Canada, Australia, New Zealand, South Africa, United States, China, and many other parts of the world to promulgate the doctrines of physiology. On Saturday, May 14, there was an ordinary meeting of the Society in Cambridge, with the business dinner meeting in Trinity College. On Sunday, Prof. and Mrs. Barcroft gave a garden party in the fellows' garden of King's College, kindly lent by the provost and fellows of the College.

THE Admiralty announces in Fleet Orders that the recommendations of the International Conference held at Washington last year in connexion with oil pollution of navigable waters have been accepted in principle by the Government, and that the main recommendation, that oil should not be discharged within 50 miles of the coast, is being voluntarily adopted by British shipowners. This step will be welcomed by bird lovers and residents on the coast, where oil on the water and clinging to weeds and stones in the intertidal zone does increasing harm to the birds and to the amenities of the seashore. Among other provisions of the Convention—which takes effect as soon as the ratifications of five of the Governments represented at the Washington Conference of June 1926 have been notified to the United States Government—is that no dues based on tonnage are to be charged in respect of any space rendered unavailable for cargo by the installation of apparatus for separating oil from water. Upon the perfection and general adoption of such apparatus, a considerable amelioration of existing conditions may be expected.

THE woods of Glencoin and Stybarrow, which overlook the head of Ullswater, are threatened with the axe. Energetic local action has been able to stay the danger pending the result of an appeal for funds to

purchase the property. The public has responded generously, but approximately £600 is still required to make up the agreed sum, and the option expires on June 30. If the money be not raised by that time all the trees will be felled this autumn, to the grave loss of the amenity of the district, a recognised beauty spot in the Lake Country. If the purchase money be raised, the land and trees, comprising an area of 180 acres, will be presented to the National Trust or some similar body. The Committee makes a final appeal, which we endorse, for immediate contributions to meet the relatively small amount still outstanding; any donation will be gratefully received by the Hon. Treasurer, Mr. H. T. Roberts, Hawkhowe, Ullswater, Penrith.

A NEW annual archaeological publication, to be entitled "Vestigia, or The Year's Archaeology in Pictures," is announced. It will contain a comprehensive selection of photographic reproductions of discoveries made throughout the world in the course of each year. The first part will cover the year ending June 30, 1927. The contents will be entirely pictorial except for a general introduction by Mr. Stanley Casson. The Trustees of the British Museum have already granted a licence to reproduce illustrations relating to the expeditions under their control for a period of five years, and similar arrangements are being made in respect of the other more important excavations now being carried on elsewhere. The publishers are "European Books, Ltd.," Henrietta Street, London, W.C.2.

THE American Geophysical Union held its eighth annual meeting this year on April 28 and 29 at Washington. The programmes of the six sections were of considerable interest, and the report of the meetings should prove valuable and attractive. The sections of geodesy, and of terrestrial magnetism and electricity, occupied the first morning; the former was concerned with progress reports on geodesy in the United States and Canada, and discussions of world-longitude nets and variations of mean sea-level; the latter section discussed correlations of various radio phenomena with solar and terrestrial magnetic and electric activities. The first afternoon was devoted to the sections of oceanography and volcanology; the problems discussed by the latter range from the United States and Japan to the moon. On the following morning the section of meteorology held a discussion on measurements of the sun's ultra-violet radiation and of the ozone content of the upper atmosphere, while the section of seismology considered progress reports from various institutions, and some theoretical and instrumental problems. On the last afternoon the general assembly held a symposium on some factors of climatic control. The Union also arranged a week's exhibition of apparatus and other material bearing on geophysical research.

SILICA valves are now used by the Admiralty for radio communication. Silica has many properties which render it particularly useful in this connexion. It does not soften until its temperature attains about 1600° C. and it has a low coefficient of thermal

expansion. The silica envelope is very diathermanous to the radiation from a red-hot anode, and so cooling by radiation can be adopted. This type of valve was discussed in a paper read on May 4 to the Institution of Electrical Engineers by H. Morris-Airey, G. Shearing, and H. G. Hughes. They pointed out that a most important constituent of the valve is the seal through which electrical contact is made between the electrodes and the external connexions. In the manufacture of the seal, lead is melted *in vacuo* in a thick walled silica tube. When this is done, it is found that the molten metal adheres firmly to the silica, forming a vacuum tight joint. As large currents are used when the tube is working, overheating is prevented by blowers supplying cool air continually to the seals. When valves are supplied with 15 kilowatts or more of electrical power, circulatory methods of cooling are adopted to prevent the radio office getting overheated. The heat energy from the anode is radiated through the silica envelope to a jacket containing a cooling fluid which is kept circulating by a pump. In internal cooling, the anode is made in tubular form and the cooling fluid is forced through the tube. This latter type of valve is still in the experimental stage; it has, however, many advantages. For example, a 4 kw. molybdenum anode has been used experimentally as a 40 kw. tubular spiral anode. Under working conditions, ninety per cent. of the failures of silica valves are due to a burn-out of the filament.

BEFORE broadcasting was introduced in Great Britain, many British radio amateurs used to listen to the Dutch broadcasting station at The Hague. Last March the radio station of the Philips' lamp laboratories at Eindhoven in Holland were in telephonic radio communication with Bandoeng in the Dutch East Indies. This development was made possible by using a short wave-length of 30 metres. In April the radio station at Sydney re-broadcast one of the Philips' programmes. Holland therefore is to be congratulated as the pioneer of long-distance broadcasting on short wave-lengths. The *Wireless World* for April 27 discusses the feasibility of Empire broadcasting. It seems certain that a short-wave British station of sufficient power to be heard for many hours a day throughout the British Empire could be built at no great expense. News could be broadcast and possibly Daventry programmes relayed at fixed times. This would perhaps be outside the scope of the B.B.C. and would have to be under the control of the Foreign Office and the Colonial Office. It would be a boon to many who have to live in lonely parts of the earth.

ON Friday, May 6, Air-Marshal Sir John Salmond unveiled at Cambridge a tablet to the memory of three pioneers in the application of scientific methods to aeronautical problems. Prof. Bertram Hopkinson, Dr. Keith Lucas, and Mr. Edward T. Busk all devoted great natural ability and mechanical inventiveness to the subject before they gave up their lives in their country's service. Bertram Hopkinson, professor of engineering and fellow of King's College, learnt to fly

when more than forty years of age, that he might the better understand the problems connected with the bombs, bomb-gear, and aeroplane guns with which he was confronted in the Technical Department of the Air Ministry. Keith Lucas, fellow of Trinity College, one of the most brilliant young physiologists of his day, had made considerable progress in the development of air compasses when a collision in the air cut short a career of great promise. Edward Busk had already made notable contributions to the solution of the problem of the stability of aeroplanes, when in the very early days of the War he was killed when flying at Farnborough through his machine catching fire. It is well that their devotion and zeal should be commemorated in the headquarters of the Cambridge University Air Squadron, so that future generations may share in some slight way the admiration and high regard which their Cambridge contemporaries feel for them.

SIR HENRY A. MIERS delivered the seventeenth annual May Lecture before the Institute of Metals on Wednesday, May 11, taking as his subject, "Growth of Crystals." Sir Henry recalled experiments made twenty years ago by himself and Miss Isaac which seemed at that time to show that when a solution is cooled below its saturation temperature it passes into a 'metastable' state in which crystals can only be produced by introducing a fragment of the dissolved substance or of one isomorphous with it, and that at a lower temperature it passes into a 'labile' state in which crystals may appear spontaneously. Later investigations have shown that, in the metastable state, crystallisation can also be produced by shock. Sir Henry considers, however, that his experiments record the normal behaviour of crystallising liquids, and that crystallisation only takes place with some degree of supersaturation or undercooling. In his experiments there was always a sudden outburst of crystal growth at a definite temperature. Little importance is ascribed to undercooling by most geologists in their speculations concerning the crystallisation of molten magmas, but to many metallurgists it is a very important factor. The structure of alloys is in many cases attributed to a suspended crystallisation of this nature; not only as they solidify from the molten state, but also during the crystalline changes which take place in the solid alloy with change of temperature, for example in steel and in magnetic alloys.

A LONDON meeting of the Prehistoric Society of East Anglia, under the presidency of Dr. R. R. Marett, will be held at the rooms of the Royal Anthropological Institute, by permission of the Council, on Tuesday, May 24, at 2.30 P.M. A number of papers will be presented and interesting exhibits shown. Mr. J. E. Sainty will report on the discovery of St. Acheul palæoliths at Whitlingham, Norwich, and Mr. Reid Moir will present a summary report on his recent investigations at Hoxne, Suffolk, where he has been excavating with the view of throwing further light on the problems of the boulder clay and its relation to

types of palæolithic implements. An account of the 1926-27 excavations at Kent's Cavern, Torquay, will be given by Mr. H. S. Dowie. Miss Layard will exhibit microlithic flint implements from the Colne Valley, Essex, and implements in *grès lustré* from the Forêt de Montmorency. Mr. S. Turner will show exhibits from a late palæolithic site at Stone Cross Farm, Luton, Kent. In the evening the members have been invited to attend a meeting and conversation of the Royal Anthropological Institute which will be held at the Wellcome Historical Medical Museum, by kind invitation of Mr. Henry S. Wellcome, when Prof. G. Elliot Smith will deliver a short discourse on the medical and magical aspects of the anthropological material in the Museum, and fellows and guests will be invited to inspect the collection.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Friday, June 3, when the Observatory will be open to inspection by invited guests at 3.30 P.M.

THE Rev. T. E. R. Phillips, president of the Royal Astronomical Society, will deliver a lantern lecture on the coming solar eclipse, on May 27 at 8 P.M., at the Polytechnic, 309 Regent Street, London. The lecture is in aid of King Edward's Hospital Fund for London.

At the annual meeting of the Institute of Physics on May 16, the following officers were elected: *President*, Sir Frank Dyson; *Vice-Presidents*, Prof. C. L. Fortescue, Sir Richard Gregory, Mr. R. W. Paul, Mr. R. S. Whipple; *Hon. Treasurer*, Major C. E. S. Phillips; *Hon. Secretary*, Prof. A. O. Rankine.

THE Prime Minister, Mr. Baldwin, showed his interest in optical work, and the importance he attached to the progress of the British optical industry, when he opened the very successful Optical Convention which was held in London in April of last year. The scientific work accomplished at the Convention has proved to be of wide interest and importance and has been recorded in the *Proceedings*, two substantial volumes running to more than a thousand pages. More than half of the edition originally printed has already been exhausted. Any inquiries with regard to the Convention and its publications should be addressed to the Secretary, The Optical Convention, 1926, 1 Lowther Gardens, Exhibition Road, London, S.W.7.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A full-time lecturer in the mathematics and physics department of the Polytechnic, Regent Street, W.—The Director of Education, The Polytechnic, 309 Regent Street, W.1 (May 30). A head of the electrical engineering department of Robert Gordon's Colleges, Aberdeen—The Secretary and Registrar (May 31). A head of the building trades department of the Wigan and District Mining and Technical College—The Secretary of the College (May 31). A director of the Leeds Art Gallery—The Town Clerk, 26 Great George Street, Leeds (June 1). A surveyor of shipping under the Corporation of Trinity House—The Secretary, Trinity House, Tower Hill, E.C.3 (June 1).

A head of the mechanical engineering department, a head of the electrical engineering department, and a graduate assistant in the mechanical engineering department of the Rutherford Technical College—The Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (June 3). A biochemist, a soil chemist, and a plant physiologist at the University of Bristol Department of Agricultural and Horticultural Research, Long Ashton, Bristol—The Registrar (June 4). An assistant lecturer in the Commerce Department of the Belfast Municipal College of Technology—The Principal of the College (June 9). A principal of Battersea Polytechnic, and a woman head of the Department of Hygiene and Public Health—(1) The Clerk to the Governing Body, (2) The Principal (June 13). The Bernhard Baron research studentship at the Middlesex Hospital on the anatomy, physiology or pathology of the ear, nose and throat—The Secretary of the Middlesex Hospital, W.1 (June 14). A professor of botany in the University of Sydney, N.S.W.—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (June 24). A lecturer in medieval history in the Queen's University,

Belfast—The Secretary, Queen's University, Belfast (June 27). A biochemist, an assistant plant physiologist, and an assistant pomologist at the East Malling Research Station—The Secretary, East Malling Research Station, East Malling, Kent (June 30). Test assistants at the Royal Aircraft Establishment, South Farnborough, Hants (quoting A. 174). An assistant in the building trades department of the Halifax Municipal Technical College—The Principal, Municipal Technical College, Halifax. A senior physics master at Merchant Taylors' School, Crosby, Liverpool—The Head Master. Temporary Instructor Lieutenants in the Royal Navy—The Adviser on Education, Admiralty, Whitehall, S.W.1. A junior assistant chemist under the directorate of explosives research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

ERRATUM.—At the end of Prof. Fritz Paneth's letter in NATURE of May 14, p. 706, on "The Transmutation of Hydrogen into Helium," for the date "Mar. 2" read "April 2."

Our Astronomical Column.

COMETS.—Comet Pons-Winnecke was an easy object for small telescopes early in May: both Dr. W. H. Steavenson and Mr. B. M. Peek noted a nearly stellar nucleus and a considerable coma. As the comet is steadily approaching both sun and earth, it should by now be quite conspicuous, but it is well to remember that while the position of comets can be predicted, their brightness is subject to capricious variations.

Dr. A. C. D. Crommelin has revised the orbit elements from observations on Feb. 25 and May 1 (by Merton), Mar. 4 (by van Biesbroeck). The period was assumed known; the other elements are:

T 1927 June 21-0730 U.T.
 ω $170^{\circ} 17' 15.3''$
 Ω $98^{\circ} 12' 34.0''$
 i $18^{\circ} 56' 43.2''$
 ϕ $43^{\circ} 16' 22.4''$
 $\log \alpha$ 0.5192415 (assumed)
 $\log q$ 0.0168982

Comet Grigg-Skjellerup is not likely to be so bright as Pons-Winnecke, but it is coming near the earth, so should be fairly easy to see. Its distance on June 3 is 19 million miles. Observations of position are desired.

H. Thiele has deduced elliptical elements of Stearns's comet, with a period of 9515 years, but departure from a parabola is not yet certain:

T 1927 Mar. 20 02161 U.T.
 ω $10^{\circ} 36' 11.5''$
 Ω $214^{\circ} 35' 43.2''$
 i $87^{\circ} 32' 21.0''$
 $\log q$ 0.565875
 e 0.991805

Observations used were on Mar. 13, 26, April 5. It is fading slowly, but is still a fairly easy object.

Comet Comas Sola is getting rather low in the evening sky, but should be followed for as long as possible.

Ephemerides of these comets for 0^h follow; that of Pons-Winnecke is from earlier elements and will need some correction:

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Comet.	Date.	R.A.	N. Decl.	log r .	log Δ .
Pons-Winnecke	May 20	15 ^h 9 ^m 20 ^s	58° 16'	0.0532	9.4648
	28	15 21 0	54 26	0.0383	9.3716
	June 1	15 29 40	54 50	0.0320	9.3147
	5	15 42 8	55 1	0.0268	9.2485
	9	16 0 4	54 59	0.0225	9.1688
	13	16 27 28	54 19	0.0193	9.0712
Grigg-Skjellerup	May 20	7 58 5	31 33		9.3957
	22	8 9 53	35 6	9.9591	9.3757
	24	8 23 34	38 54		9.3572
	26	8 39 39	42 54	9.9656	9.3409
	28	8 58 49	47 0		9.3272
	30	9 21 55	51 6	9.9738	9.3171
	June 1	9 50 2	55 0		9.3106
	3	10 24 5	58 30	9.9820	9.3080
	5	11 4 34	61 20		9.3095
Stearns	May 23	14 19 47	17 48	0.5715	0.4680
	31	14 13 31	19 32	0.5723	0.4820
	June 8	14 18 17	20 57	0.5743	0.4973
	16	14 4 11	22 5	0.5760	0.5139
Comas Sola	May 24	7 36 20	31 57	0.2730	0.3741
	June 1	7 59 32	31 4	0.2790	0.3873
	9	8 22 16	29 52	0.2855	0.4004

RECENT SUNSPOT ACTIVITY.—A large group of sunspots, recently in transit across part of the sun's disc, was the first to be seen with the naked eye since last January. In the interval of four months a number of smaller groups have been seen, averaging at least six daily, but there has been a noticeable absence of very large spots which are usually fairly frequent at this time of the solar cycle. The recent group, consisting of a pair of large, roughly circular spots, began as a tiny spot seen on May 9, and its rapid growth is well shown by the following measures of area, in units of millionths of the sun's hemisphere, made at intervals of approximately 24 hours:

Date	May 9	10	11	12	13	14
Area	5	150	380	870	1000	1350

One interesting feature of the group was the invariable distance apart, 6° in longitude, preserved by the two spots; in the majority of such groups the early rapid growth is associated with a considerable drifting apart of the two chief components, so that at maximum development they are separated by at least 10° in longitude. Other details of this group are given below in the usual manner:

No.	Date on Disc.	Central Meridian Passage.	Latitude	Max. Area.
4	May 9-17	May 11.7	17° N.	1/800 of hemisphere.

Research Items.

THE PICTORIAL RECORDS OF DAHOMEY.—The Institut d'Ethnologie of Paris has inaugurated a series of publications of its own, to be known by the general title of "Travaux et Mémoires," with two volumes dealing with primitive art. Of these the first, by M. E. M. G. Waterlot, is a description, fully illustrated, of the bas-reliefs of the royal buildings of Abomey (Dahomey). The interest of these polychrome bas-reliefs is dependent not only on their æsthetic qualities but also on the fact that they are historical records of achievements of the king in whose reign they were executed, or of events which took place in that reign. The occurrence in Africa of historical documents of this type, of undoubted authenticity, is a matter of very considerable interest to ethnologists. The drawings here described, of which reproductions have been made for the Musée d'Ethnographie de Paris, are taken from the palace of Agadja (1708-28), of Ghezo (1818-38), and Glélé (1838-1889). As the country over which they ruled had been conquered by their people in the early seventeenth century, and was held by force of arms, these pictorial records not unnaturally deal mainly with their struggles with neighbouring peoples and the punishments meted out to the vanquished. In addition are religious symbols, records of notable dicta of the kings, or allegorical representations of the kings themselves. They are found only on the walls of the private apartments of the kings; they were not found in other parts of the palaces, even in those portions reserved for the mothers of the kings or their representatives, or for the old women to whom was entrusted the guardianship of the tombs of the kings and of the sacred objects of the tribe.

NEW CALEDONIAN ART.—The second of the *Mémoires et Travaux de l'Institut d'Ethnologie*, Paris, is a study of New Caledonian art by M. G. H. Luquet, based to a great extent upon material collected by Marius Archambault. M. Luquet, whose studies of prehistoric and primitive art have won him a position as a recognised authority, has analysed the material from the viewpoint of an æsthetic critic and psychologist. After a detailed examination of the specimens and a classification of the motives found in both the petroglyphs and the engravings on wood or bamboo, he concludes that the characteristic feature of the petroglyphic art is not so much the cross in its various forms, as was thought by Archambault, as the representation of the stylised human form and especially the human face. Nor is he able to agree with Archambault that the petroglyphs represent the art of a vanished race. They are merely one manifestation, the earliest, of what is essentially a single artistic activity with identical motives, identical spirit, the same tendencies, and the same æsthetic surviving even down to the present day, given certain modifications due to difference in material, and changes in objects represented on the introduction of European civilisation. The proportion of engravings with a religious motive is probably small. The strongest impulse to artistic representation is probably purely æsthetic, with a strong tendency to intentional stylisation, rather than the result of a schematisation due to repeated or careless reproduction of a motive originally realistic. New Caledonian art would appear to afford no support to the view that naturalistic art belongs to hunting peoples, while schematic art is the product of an agricultural mode of life.

VITALITY OF YOUNG ANIMALS.—Mr. E. L. W. Heck, of Cambridge, Mass., in a letter to NATURE, states that in certain experiments relating to the educability

of the albino rat, rats from the age of 21 days are trained to avoid an electric shock. During the first two or three days of training the shock seems to have very little effect upon them, but thereafter its effects become progressively more pronounced, so that after two weeks have passed it is not uncommon for the rats to be killed by the shock. For this reason it was found that the greatest care had to be exercised during the fourth and final week of training. These observations, if confirmed, are of interest, since they are opposed to the general conclusions reached by Child, whose experimentation showed quite clearly that with reference to narcotics generally, young animals beyond a certain stage of growth show the highest susceptibility, and that this susceptibility decreases with advancing development. The swing in the degree of susceptibility is related to a change in metabolism from a higher to a lower level.

THE DISTRIBUTION OF ANOPHELINE MOSQUITOES IN SCOTLAND.—In the *Proceedings of the Royal Society of Edinburgh*, vol. 47, Part I. (No. 6), 1927, Prof. J. H. Ashworth discusses this subject and provides some new records. In Scotland the available evidence indicates that *Anopheles bifurcatus* is the most abundant and widespread species, whereas in England *A. maculipennis* predominates. So far, the latter species has been met with only in four localities in the Highlands, while *A. plumbeus* occurs over a considerable portion of the eastern coastal region of Scotland. Details of the only case of indigenous malaria in Scotland since that disease became compulsorily notifiable in 1919, are quoted from the Report for 1919 of the Medical Officer of Health for Glasgow. A woman patient suffering from malaria had resided at Kirriemuir (Forfarshire) at a time when troops were present, and it is surmised that she was bitten by a mosquito which had acquired the malaria plasmodium from an infected soldier. The results presented in this paper constitute data for commencing a survey for *Anopheles* in Scotland, and the paucity of records of the genus in that country is merely an indication of the small amount of attention that the subject has yet received. It is noteworthy that such records as do exist tend to congregate where observant collectors reside, namely, around Edinburgh and Glasgow.

THE SHOT-HOLE BORER OF TEA.—The Shot-hole Borer (*Xyleborus fornicatus*) has been considered one of the worst pests of tea in Ceylon for the past twenty years. During the last half of this period almost every possible control method has been examined and various recommendations have been made, but without the desired result being achieved. In Bulletin No. 78 of the Department of Agriculture, Ceylon, Messrs. F. P. Jepson and C. H. Gadd discuss manuring in relation to the control of this insect. In Part I of this Bulletin (by Mr. Jepson) it is stated that some measure of relief from the depredations of the Shot-hole Borer might be expected from the adoption of special cultural methods and the utilisation of natural enemies. It is with the first method that this Bulletin is concerned, and extensive experiments were set up in order to ascertain the relative values of nitrogen, potash, phosphoric acid, and lime in the control of the pest in question. The interpretation of the results of these trials form Part 2 of the Bulletin (by Mr. Gadd). It appears that none of the treatments exercised any direct effect on the beetles, and the main benefit derived from the application of manure was the accelerated healing of the galleries bored by the insects in the tea plants.

The healing was most marked in the plots treated with nitrogenous manures, this process being complete in 2.9 months, whereas in the control plot healing was not complete until after 3.75 months. It is concluded that the manuring of tea offers a satisfactory method of diminishing the effects of attack by the Shot-hole Borer. Manuring for this purpose should aim at increasing the nitrogenous content of the soil.

COPPER DUSTS AND SPRAYS FOR POTATOES.—The results of trials undertaken to determine the relative efficiency of certain copper dusts and sprays in the control of potato diseases and insect pests are published by O. C. Boyd in Bulletin 451 of the Cornell University Agricultural Experiment Station. With light applications it was found that Bordeaux spray mixture covered a larger area than copper-lime dust containing equivalent copper per unit area, owing to the greater number and surface area of the spray membranes. Retention of the copper also was considerably greater on the sprayed than on the dusted foliage, though the dust adhered better if the potato foliage was thoroughly moistened, and consequently the effectiveness of the dust in disease and insect control was thereby improved. The use of Kayso, a casein spreader, did not increase the adhesiveness of either copper-lime dust or two Bordeaux powders, but it effectively increased the spreading powers of the spray. As regards disease and insect pests, under good working conditions, early and late blight and aphid attack were equally well controlled by copper-lime dust or Bordeaux spray mixture containing equivalent copper, though the spray proved superior in the case of flea beetles, leaf-hoppers, and tipburn. The addition of nicotine to the copper-lime dust increased the effectiveness of this substance against aphids, but an addition of sulphur was useless. Leaf injury resembling that induced by spraying blue vitriol on dry foliage occurred with copper-lime dusts containing 10 per cent. or more copper; lower quantities, however, were not harmful. Heavy applications, whether as dust or spray, were deleterious to plant growth apart from local leaf injury, and mechanical damage by machinery was to some extent unavoidable. The preference seems to be for the use of sprays rather than dusts, the average plant yield on sprayed plots being higher than that of dusted ones, and further, the cost of spraying was slightly less than that incurred with home-mixed copper-lime, and considerably less than when commercial dusts were employed.

PHYTOGEOGRAPHY OF GREENLAND.—C. H. Ostenfeld has added two more papers to his list of publications on the vegetation of Greenland (*Saertryk af Meddelelsar om Grønland*, 68, and *Det. Kgl. Danske Videnskabernes Selskab., Biologiske Meddelelser* 6, 3, 1926). The former memoirs dealt for the most part with the floras of specific localities in Greenland; the two papers just issued now collate and focus the results of the author's several years' investigations and give a comprehensive survey of the whole problem. The immigration of the flora of Greenland has been the subject of discussion by many authors, including such eminent workers as Hooker and Warming, but the knowledge and experience of Dr. Ostenfeld in the field of phytogeography in general and in that of the Arctic and sub-Arctic regions in particular, make his conclusions of a high degree of importance. The author's 15 phytogeographical districts are populated by 390 species of vascular cryptogams and phanerogams, falling into three categories, high Arctic, Arctic, and sub-Arctic to boreal. He considers about sixty species as having survived from pre-glacial times somewhere

in Greenland, and this may account for the occurrence of some of these species in Arctic countries of both the eastern and western hemispheres. Of the remaining species he comes to the conclusion that 74 are immigrants from Europe, the majority having been introduced by Norse settlers not more than nine hundred years ago. The other 256 species must be regarded as having come from America. In this connexion, among immigration routes, special attention is directed to the narrow Smith Sound and Kennedy Channel route to the north-west. On account of the fact that a post-glacial heat maximum existed, this route could have been followed by more southerly species than at the present day. Mention is also made of immigration from the north-east with the drift ice of the polar current. For the rest, immigration must have been effected by wind and birds carrying seeds across the sea. Special importance probably attaches to the action of the wind in winter, when seeds and portions of plants can be swept along over the frozen straits before the storm. It is considered unnecessary to assume any post-glacial land connexions to the west and east.

DESTRUCTION OF ICEBERGS.—Some interesting records of the effect of the application of high temperatures on icebergs are to be found in an article by Prof. H. T. Barnes in the *Marine Observer* for May. The rapid destruction of icebergs is best effected by the production of an internal disruptive force. In order to produce this force Prof. Barnes used thermit as the explosive, by which a very high temperature can be produced at a selected spot. His experiments were carried out in Notre Dame Bay, Newfoundland, on drifting bergs. One berg was about 100 feet above the water line and 500 feet long by as many wide. The berg appeared to be solid and fresh. A hundred pound charge was let into the ice in a 3-foot boring. The immediate effect of the explosion was much audible cracking and some visible disruption, but it was not until the next day, and the day following, that the full effect of the disruption was visible. Photographs show that within two days the berg, though still formidable, had been very much reduced in size. A smaller berg, about a hundred feet in diameter, was practically destroyed within twenty-four hours by the use of two charges of thermit fired simultaneously.

TECTONICS AND PETROGENESIS.—The attention of petrologists is directed to an important monograph by Prof. W. N. Benson on "The Tectonic Conditions accompanying the Intrusion of Basic and Ultrabasic Igneous Rocks," which is published in the *Mem. Nat. Acad. Sci.*, vol. 19, No. 1, 1926. A world survey of the rocks concerned is made and a provisional tectonico-petrographic classification is suggested. The suites or kindreds that are recognised include the following: the *green rocks* of the Alpine type associated with planes of shearing in former geosynclinal zones; the *spilites* formed on the margin of geosynclines; *laccomorphic complexes* such as those of Sudbury and the Bushveld in which there is no dominating lateral pressure; *cordilleran complexes* in which lateral pressure is a controlling factor; the *dolerite sills*, a uniform group invading broad areas of approximately horizontal strata; the *alkaline plateau group* in regions of vertical block-faulting; and the *alkaline peridotite* dykes related tectonically to the last-mentioned suite. It is concluded that each suite is very generally associated with a definite set of tectonic conditions, and the importance of the latter in determining the morphology of igneous masses and in controlling the processes of magmatic differentiation is emphasised.

PETROLEUM IN PERSIA.—In January last, at a meeting of the Royal Society of Arts, Sir John Cadman gave an interesting account of the development of the petroleum industry in Persia (*Jour. Roy. Soc. Arts.*). So far back as 1872 de Reuter endeavoured to locate oil in that country, but without success; there followed the activities, in the early 'nineties, of the Persian Mining Corporation, which sank two wells at Daliki, not far from Bushire, in the neighbourhood of an oil seepage, but this also proved abortive. W. K. D'Arcy, with whom the beginnings of the Persian oil industry will always be associated, started operations in 1901 and acquired from the Persian Government a concession which covered the greater part of southern Persia; early efforts to locate a commercial store of oil were most discouraging, and it was not until 1908 that the great Persian field was first proved by the bringing-in of a gusher at Masjid-i-Sulaiman, a valley in the Bakhtiari Hills, some hundred and fifty miles from the head-waters of the Persian Gulf. The formation of the Anglo-Persian Oil Company came about in the following year, since when the remarkable development of this great oilfield is a matter of common knowledge. To-day Persia occupies fourth place on the list of oil-producing countries, having an annual output of more than 4,500,000 tons; the proven area of the field is great, in length more than twenty miles, but there is still much unproven and potentially good territory. From the small initial staff (scarcely a score in number) responsible for early developments, the personnel has now swollen to literally a multitude, more than 1000 Europeans, 3000 Indians, and 25,000 Persians being employed. This in itself conveys some idea of the magnitude of operations of the Company in Persia and of the rapid growth of a great industry.

TEETH OF CRETACEOUS MAMMALS.—In the March issue of the *Scientific Monthly*, Prof. W. K. Gregory has published a further account of the very important Cretaceous mammals found in Mongolia by the expedition of the American Museum of Natural History. The article is semi-popular and is of general interest. There are good illustrations of the locality where the finds occur and figures and diagrams of the specimens. For the specialist, the chief interest is in the clear explanation and diagrams of the author's view as to the evolution of the teeth. The old Cope-Osborn tributercular theory becomes considerably modified in that the 'protocone,' which was thought at one time to represent the original reptilian cone, is now shown to be a secondary cusp. The original single cusp is shown to divide into the paracone and metacone, and the tributercular tooth is formed not by a rotation of secondary cusps anterior and posterior to the central one, but by a growth inwards from the divided chief cone of a spur on which the so-called 'protocone' arises.

THE SPECIFIC HEAT OF HYDROGEN.—Dr. F. Hund's second paper on the significance of band spectra (*Zeitschrift für Physik*, 42, p. 93, 1927) deals in addition with the closely allied problem of the specific heat of hydrogen between the high temperature region where both rotation and translation occur, and the low temperature region where the former is practically absent. The relative statistical weights of the members of either odd or even rotational quantum levels can be predicted from theory, but there is no correlation between odd and even terms. Comparison of theory with experiment is rendered difficult because the moment of inertia of the molecule is also unknown. The form of the specific heat-temperature curve can, however, be predicted if even

terms are assumed to be an arbitrary factor (f) times as frequent as odd terms, and the position of the curve can then be fixed by choosing a moment of inertia so that the empirical and theoretical values of the specific heat are the same at the convenient temperature of -77°C . The factor f is then found by observing which of the theoretical curves agrees best with the experimental measurements. The most concordant results are obtained with f equal to 2, but it is not possible to specify it exactly. The moment of inertia can nevertheless be determined fairly closely, and would only have to be increased by 10 per cent. if even rotational terms were three times as probable as the odd, instead of being twice as probable.

COLOURING OF METALS BY POLISHING.—J. A. Wasik, of the Physical Laboratory at the Polytechnic Institute, Warsaw, communicates the following observations made by him subsequent to his work on the electrical conductivity between polished metal surfaces (see also his papers in *Zeit. f. tech. Phys.*, 5, 29-31, 1924; *L'Onde électrique*, 35, 535-541, 1924; *Zeit. f. Phys.*, 3, 720-21, 1926). In preparing flat polished surfaces of metal, using aluminium oxide as polishing powder and base blocks of different materials such as pitch, glue, shellac, or lime, coloured layers were found to be produced on the metal surfaces, provided the polishing powder was sufficiently fine. Thus with iron the colours gold-yellow, brown, nearly black, clear blue, and green were obtained, the most difficult colour to obtain being that of the metal itself. These layers resist oxidation very well and several of them show exceptional resistance to the action of acids. They differ much in hardness and elasticity. M. Wasik considers that the colours obtained cannot be explained by oxidation or by interference effects, as they undoubtedly depend on the material of which the polishing base block is made, and probably on the nature of the surrounding gases; they are differently disposed (on the surface) from the oxidation colours often obtained with cloth polishing. He believes that the coloured surface films are of the nature of isotropic vitreous enamels filling the interstices between the metal grains, covering the surface and giving it lustre (reference is made to the amorphous Beilby layer); and he suggests that attention should be turned to various phenomena connected with the polished surface of metals, for example, the Kerr effect.

MAGNETIC RESEARCH.—The issue of *Science Progress* for April contains an article on recent developments in magnetism by Dr. E. C. Stoner, which will prove very acceptable to those who have not the time to read Dr. Stoner's recent book on the subject. Starting with the electron rotating about a positive centre of force, he shows how an atomic system in which the magnetic moments due to the electrons balance out will behave diamagnetically, while if they do not balance out it will be paramagnetic. The effects of temperature are then dealt with, and finally the conception of the molecular field is introduced to account for the properties of ferromagnetic substances. On these general principles as a basis, the author goes on to recent work on the magnetic properties of atoms and ions, dealing in particular with the magnetic deflexion of the atoms streaming from heated metals, and with the atomic moments of iron, nickel, and cobalt, and the magnetic properties of crystals. Dr. Stoner does not think that the spinning electron theory helps forward magnetic theory to any great extent, nor does he appear to abandon atomic models in favour of the matrix method or of the undulatory mechanics method of dealing with the properties of the atoms.

Land in the Arctic.

THE study of the Arctic tides attracted wide attention when Harris concluded from his stationary wave-theory in 1911 that an extensive area of land existed within the unexplored area of the Arctic regions. Nansen, on the contrary, inferred the existence of a deep Polar basin from his observations in the *Fram* between 1893 and 1896.

Harris's hypothetical land gave a stimulus to explorers, but their search was fruitless. Stefansson, on his remarkable journeys over the sea-ice north of Alaska, and McMillan on this Crocker Island expedition, both touched the outskirts of the unknown region without finding anything but broken sea-ice. Amundsen in 1926 passed over the central part of the unexplored region in the dirigible *Norge* without seeing any land. Between 1918 and 1925 the *Maud* expedition made numerous tidal observations in the area north of Siberia. These observations, combined with earlier data, have been critically examined by Sverdrup and indicate in this area a tidal wave of the progressive type, differing from the stationary type deduced by Harris; nor do they indicate the existence of any extensive masses of land within the unexplored region.

The illustration here reproduced (Fig. 1) from Sverdrup's papers¹ shows the cotidal lines (the times of high water, in terms of Greenwich lunar time at full and new moon), and indicates that the progressive tidal wave from the north Atlantic enters the opening between Greenland and Spitsbergen and crosses the Arctic Sea without meeting any obstruction caused by extensive land masses. The figure reveals that the tidal wave reaches De Long's Island five hours before

it reaches Point Barrow, although the direct distance from the Spitsbergen opening to the Island and to Point Barrow is nearly the same. This suggests a shallow sea in the unexplored region north of Wrangel Island and Point Barrow, with perhaps islands in places.

The tidal streams met with were of the rotary type usual in open ocean areas, but they present a striking peculiarity. Below the ice to a depth of some twenty fathoms water of the same density is present, while below this there is a sudden increase in density and

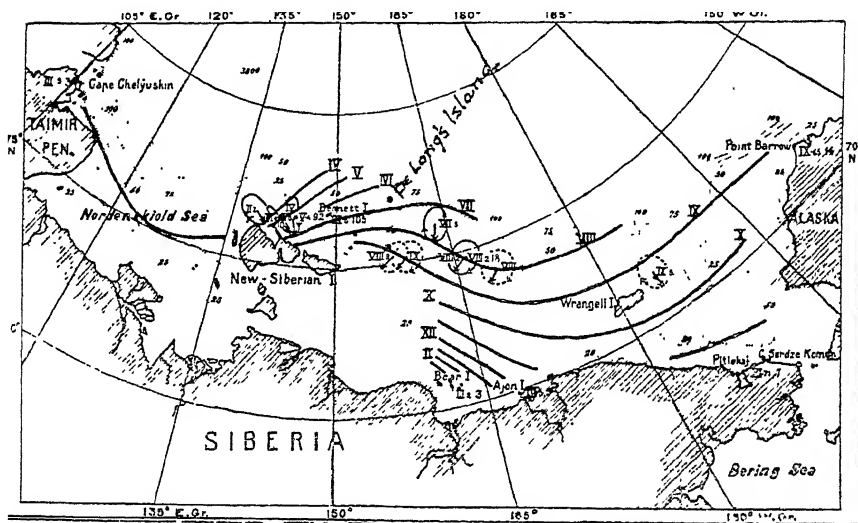


FIG. 1.—Tidal observations and co-tidal lines at spring tide on the north Siberian shelf.

later a slow increase on approaching the bottom. In the water layer of equal density the tidal streams ran slow, but in the layer where density increased rapidly with depth the tidal streams were at a maximum, dying away towards the bottom.

The water can be considered as composed of three layers of different eddy-viscosity. In the upper layer of equal density vertical eddies are free to be developed and the eddy-viscosity or 'virtual' viscosity is great. In the intermediate layer of rapidly changing density vertical motion is restrained and the eddy-viscosity is low, while below this, where there is a slower increase in density, the eddy-viscosity is of an intermediate value.

H. W. H.

The Initial Phase in Gaseous Explosions.

WHILE an atmosphere of controversy is not perhaps the best for the calm interpretation of scientific facts, there is no doubt that the clash of opinions gives a zest to research and sometimes speeds up discovery. The slow uniform movement of flame in the initial phase of the explosion of gases—first studied by Le Chatelier—has given rise to such a controversy between Prof. W. A. Bone and his colleagues at the Imperial College of Science and Technology, South Kensington, and Prof. R. V. Wheeler and his colleagues at the Safety in Mines Research Laboratories at Sheffield.

There is no doubt that many explosive mixtures, when lighted at the open end of a long tube, burn with a slow uniform movement for a certain distance, and as a rule this uniformity is more marked the slower the propagation of the flame. When 'limit' mixtures of various saturated hydrocarbons with

air, *i.e.* mixtures which would just propagate flame, were ignited at the open end of a tube, Prof. Wheeler and his colleagues found that the flame had an initial uniform movement which was the same for each mixture; and, moreover, when any two of these mixtures were mingled together, the complex was also a 'limit' mixture and burnt at the same rate. So far, we understand, the speed-law is unquestioned. But when the law is extended to non-limit mixtures and to all gaseous mixtures of the same type (*i.e.* with either excess of combustible or excess of oxygen), which have the same uniform speed of flame, the two schools are in disagreement. Prof. Bone (with Messrs. Fraser and Winter) has just published in the *Proceedings of the Royal Society* photographs of the flames initiated in ethylene-oxygen, acetylene-oxygen, and in hydrogen-oxygen mixtures. He finds that such fast-burning mixtures do not always show any

¹ "The Tides on the North Siberian Shelf: their Bearing on the Existence of Land in the Arctic Sea and their Dynamics," H. U. Sverdrup, *Journal of the Washington Academy of Sciences*, vol. 16, pp. 529-540 (Washington, Dec. 1926).

uniform movement, and sometimes give in successive experiments uniform movements of different speeds. No doubt such mixtures are very sensitive to slight changes in the application of the igniting flame and the possible setting up of turbulence, and the length of the tube might affect the result.

Experiments to test the speed-law with blends of an ethylene-oxygen and a methane-oxygen mixture respectively with an hydrogen-oxygen mixture gave results which fell progressively below the predicted rates according as the hydrogen mixture was increased in the blend. It has been pointed out, on the other hand, that the rate of chemical change (and therefore the spread of the flame) is subject to the law of mass-action; the curve predicted by the speed-law diverging from the experimental speeds as the combustible gas approaches the upper limit of propagation. The speed-law has some exceptions, evidently: do they prove the rule?

In Part 3, Prof. Bone (with Messrs. Fraser and Witt) shows photographs of the initiation of the explosion of an equal mixture of methane and oxygen in the centre of a closed tube under the influence of sparks varying in character and intensity. With the feeblest sparks there seems to be a short period of 'induction' with no visible flame; then a 'ghost-like' flame spreads with acceleration until it is checked before it reaches the ends of the tube, and finally there is the intense illumination traversing the whole column of gas in waves from end to end. With the intenser sparks the flame spreads at once and luminous striæ describe wavy paths within the ghost-like flame. The very luminous waves are caused by reflections from the closed ends: they are not shown when the ends of the tube are opened before firing. The powerful sparks evidently provoke rapid combustion in their neighbourhood.

A University Centre in London.

A MOST important announcement in relation to the future of university education in London was made at the Graduation Dinner of the University on May 11. Aided by a grant from the Government and a generous gift from the Rockefeller Foundation, the university has been able to arrange for the purchase of the Bloomsbury site of 11 acres, including roads, or 8½ acres excluding roads, north of the British Museum. This site was purchased by the Government in 1920 and offered to the University under conditions which the University was unable to accept, with the result that after five years the site was re-sold to the vendor, the Duke of Bedford, in accordance with the terms of the conveyances.

The Vice-Chancellor, Sir William Beveridge, indicated some of the purposes for which the site will be used, including University offices, Senate House, Library, Ceremonial Hall, Examination Hall, the Institute of Historical Research, a Faculty Club for Teachers, a Students' Union, O.T.C. Headquarters, perhaps one or two colleges, and finally, the beginning of residential quarters for teachers and students. He described in eloquent terms his vision of the future University of London, and appealed for the inspired artist who would embody it in stone and steel, "who will bring into the very heart of London a group of buildings that, raising their towers and pinnacles to the sky, will form a shrine of youth and learning in Bloomsbury to rank with the shrine of our history and our liberties by the Thames at Westminster." Lord Eustace Percy, President of the Board of Education, who was the guest of honour at the dinner, said that the announcement marked a great and historic moment in the history of the

University. It will be generally hoped that the change of home will mean a change of heart, and that the feuds and wrangles of the past will soon become a fading memory. "The final decision," the Vice-Chancellor said, "was unanimous and is a pledge of unity for the future."

As to new developments for scientific research, no information was forthcoming. The general policy of university research institutes is still an open question, the discussion of which should now, however, take a new orientation; and a claim to part of the site will no doubt be advanced on behalf of sciences for which at present research facilities are inadequate. Provision should also be made for public university lectures. Referring to the financial position, the Vice-Chancellor said that, after purchasing the site, there was money in hand for the Central Offices. "The rest must wait for further help." The amount of the munificent contribution from the Rockefeller Foundation was not divulged.

University and Educational Intelligence.

CAMBRIDGE.—By the will of the late Prof. A. W. Scott, of Lampeter College, the University is to receive £7000 and a third of the residue of his estate, approximately a further £4000, for the furtherance of physical science.

Sir Josiah Stamp will deliver the Rede Lecture on June 8 on "Stimulus in the Economic Life." Prof. A. E. Taylor, of Edinburgh, will deliver the Leslie Stephen Lecture on June 3, on "David Hume and the Miraculous."

Mr. J. E. Purvis, Corpus Christi College, has been re-appointed University lecturer in chemistry and physics in their application to hygiene, and Mr. A. Hopkinson, Emmanuel College, has been re-appointed demonstrator of anatomy.

LONDON.—Applications are invited for the University studentship in physiology, value £50, which is open to a student qualified to undertake research in physiology. The latest date for the receipt of applications by the Academic Registrar, South Kensington, S.W.7, is May 31.

MANCHESTER.—An anonymous donor has given about £5000 for the endowment of two post-graduate scholarships for research in plant and animal biology.

OXFORD.—The University statutes have been modified to enable the committee for advanced studies to make grants of money for equipment needed by students for the degree of B.Sc.

The great and rapid development of the School of Rural Economy and of the various agricultural institutes affiliated to it from 1908, when it began with a modest grant of £800, to the present time when it has received a total grant of £44,000, has determined the passing of a new statute to redefine and strengthen the functions and powers of the Committee for Rural Economy. The Committee will have general control of the available funds, and will appoint directors and research officers for the two institutes for research in agricultural economics and agricultural engineering and for the advisory institute.

A new medical travelling studentship has been founded in memory of Dr. George H. Hunt. The value will be somewhat less than £100 every other year. Candidates must be graduates in medicine who shall have not exceeded five years from the date of passing their final M.B. examination; they will be expected to travel abroad for a period of not less than three months for clinical study or medical research, and eventually to engage in practice as surgeons or as general practitioners.

PROF. C. A. EDWARDS, professor of metallurgy and acting-principal of the University College of Swansea, has been appointed Principal of the College in succession to Dr. Sibly. Prof. Edwards will continue to act as professor of metallurgy and will supervise the work of honours students and direct research in the department.

APPLICATIONS are invited by the London County Council for two Robert Blair fellowships in applied science and technology, each of the value of £450 and tenable for one year. Applicants must be British subjects and not less than twenty-one years of age. Particulars and application forms (T.2.a./300) are obtainable from the Education Officer (T.2.a.), the County Hall, S.E.1. Forms must be returned by June 18.

THE Ramsay Memorial Fellowship Trustees will consider, at the end of June, applications for a Ramsay Memorial Fellowship for chemical research. The value of the fellowship will be £250 per annum, to which may be added a grant for expenses not exceeding £50 per annum. Applications must be received not later than June 6. Full particulars as to the conditions of the award are obtainable from the Secretary, Ramsay Memorial Fellowships Trust, University College, London (Gower Street, W.C.1).

At a meeting of Armstrong College Council held on May 16, the resignation was accepted with regret of Prof. J. W. Bews, professor of botany. Prof. Bews, who came to Armstrong College from University College, Natal, in January 1926, has found the English climate unduly trying for both his wife and himself after fifteen years' residence in South Africa, and he is returning to his old post in Natal. The Council has appointed Mr. J. W. Harvey to be professor of philosophy in succession to Prof. A. S. Ferguson, now Regius professor of logic in the University of Aberdeen. Mr. Harvey, who is at present a lecturer in philosophy at the University of Birmingham, was educated at Rugby and Balliol College, Oxford; he has also studied in Berlin and Marburg. He is the English translator and editor of Prof. Rudolf Otto's "Das Heilige," which appeared under the title "The Idea of the Holy," and has collaborated with others in a small book entitled "Competition: A Study in Human Motives," published in 1913. Mr. Harvey is a member of the Society of Friends.

THE project of a university college at Hull, and the steps taken towards realising it, are described by the principal—Prof. A. E. Morgan, formerly of the University of Sheffield—in the April number of the *University Bulletin*. It is hoped that building operations will be started during the summer of this year, but it is doubtful whether the college will be ready to open its doors to students before 1929. The issue also contains an exceedingly interesting letter from Prof. G. S. Brett, of the University of Toronto, on university education in Canada. "The two vital questions seem," he says, "to be numbers and politics. If numbers steadily increase a special effort must be made to distinguish between genuine students and those who merely 'go through' the university. This effort will depend in the last resort on the attitude of those who pay the bill; if they have wisdom and know the value of educational ideals for a country, the otherwise inevitable degeneration will be avoided." The operations of the Anglo-German Academic Board in developing a system of interchange of university graduate students between Germany and England are described, and the address of the president of the Association sums up the work standing to the credit of the Association.

Calendar of Discovery and Invention.

May 22, 1724.—The total solar eclipse which occurred on May 22, 1724 (May 11, O.S.), was the last total eclipse seen in England. A copy of Halley's map of the path of the shadow crossing Ireland, south-west England, France, and southern Germany is to be seen in the Astronomical Gallery at the Science Museum. The eclipse was observed by Maraldi and J. Cassini at Trianon and by Delisle at Paris. At Trianon the period of totality was 2 minutes 16 seconds. Venus, Mercury, and a few of the fixed stars were visible to the naked eye, and it was noted that "a corona of light was seen to encompass the dark body of the moon during the totality of the eclipse." According to a note in *NATURE* of April 29, 1875, p. 507, an account of the eclipse was given in Stukeley's "Itinerarium Curiosum."

May 22, 1735.—Though Galileo, Halley, and Hooke had discussed the air currents of the world, George Hadley was the first to study adequately the direction of these currents, his views being given to the Royal Society on May 22, 1735, in a paper entitled "Concerning the cause of the General Trade Winds." It was, however, many years before the value of his writings was recognised.

May 24, 1753.—Carl Linnæus, the Swedish naturalist, published the first portion of his celebrated "Species Plantarum," in which he brought into use his "nomina trivialia," or two names, generic and specific, in place of the cumbrous sentences previously employed; the first part consisted of pages 1-560; the rest came out in the month of August.

May 24, 1844.—In 1843 the Senate of the United States voted 30,000 dollars to enable Morse to erect an experimental electric telegraph line between Washington and Baltimore. On May 24, 1844, the first public exhibition of the working of this line took place. Sitting in the Supreme Court of the Capitol in Washington, Morse signalled the words, "What hath God wrought," the message being received and repeated by Alfred Vail at Baltimore.

May 25, 1812.—Davy's beneficent work on the study of mine explosions and the invention of the miner's safety lamp were the direct outcome of the disastrous explosion at Felling Colliery, Sunderland, on May 25, 1812, when 92 lives were lost.

May 26, 1798.—Among many ingenious methods of raising water is that of the hydraulic ram devised by John Whitehurst of Cheapside about 1770, but improved and made automatic by Montgolfier, who patented it in France on May 26, 1798, and was awarded a gold medal at the French Exposition of 1802.

May 27, 1846.—For many centuries the only explosive in use was gunpowder. The first of the modern explosives to be introduced was gun-cotton, discovered by Schönbein and described by him to the Scientific Society of Basle on May 27, 1846. There are, however, earlier references to it in Schönbein's letters to Faraday. In October 1846 the British Government voted £1500 for experiments with the new explosive.

May 28, 1898.—Among the important investigations carried out at the Royal Institution, few have surpassed in interest those on the liquefaction of gases initiated by Faraday in 1823 and continued sixty years later by Dewar. Cailletet first saw liquid oxygen in 1877, and Olszewski also liquefied it in 1883. Fifteen years later, on May 28, 1898, Dewar obtained liquid hydrogen, and the following year at the centenary celebration of the Royal Institution gave a demonstration of his methods.

E. C. S.

Societies and Academies.

LONDON.

Royal Microscopical Society (Liverpool Conference), Mar. 30 and 31.—C. O. Bannister: Crystallisation of silver beads and detection of platinum metals by the microscope. In the presence of small quantities of platinum or palladium, the normal crystallisation of silver is displaced by a banded structure. In the presence of iridium, the silver beads are much more spherical in shape and the crystal faces are covered with lines similar to slip bands. With traces of rhodium, a distinct crystallisation of silver results, each face being frequently covered with parallel straight lines quite different from those caused by iridium. With additions of ruthenium, the markings on the crystal faces have a single-sided herringbone structure.—Conrad Beck: The best method of illuminating metallurgical specimens. The most minute structure that has yet been photographed under the microscope with ordinary light is shown in Mr. H. Wrighton's photographs of steel, where the finest lines are about 150,000 to the inch. Mr. Wrighton's method of illumination produces the ultimate theoretical resolution possible; it depends upon the utilisation of the full aperture of the apochromatic object glass in use and limits the beam of light so that although it fills the aperture, it allows no light beyond that forming the image to enter the microscope.—Ruth C. Bamber (Mrs. Bisbee): A simple method of demonstrating the anatomy of trematodes. The details given refer to *Distomum hepaticum*:—(1) Wash well by shaking in normal saline; (2) immerse in fresh water for four to twenty-four hours; (3) place in 3 per cent. glacial acetic acid until differentiation is complete; (4) place in fresh water under a piece of glass heavy enough to compress the animal slightly. Examine with a binocular microscope or a hand-lens, and with reflected and transmitted light. The times vary with the size of the specimens. Differentiation is progressive. When complete, all the systems of the body, except the excretory system, show up by reflected light as though painted in Chinese white on a semi-transparent background. The excretory system is seen very clearly by transmitted light early in the process of differentiation.—W. E. Cooke and C. F. Hill: Pneumokoniosis due to asbestos dust. Although the asbestos industry is more than two thousand years old, only two cases of lung disease due to asbestos dust appear in medical literature. The present case was unique in two respects. First, the particles found in the lungs were large—some measuring 360 microns in length—and were proved to be the brittle iron-containing part of the asbestos fibre. Chemical analyses of the mineral in the various processes of manufacture and of the dust were compared with the microscopical appearances, and it was proved that the dust contained 18 per cent. of iron as ferrous oxide, the raw material 2.1 per cent., and the finished article 0.1 per cent. The second feature was the presence of a fungoid body. Some deny that it is a fungus, others contend that it is an aspergillus. The authors incline to the view that it is a hyphomycete analogous to that found by Dr. H. H. Scott in batrachians, or that it belongs to the family of hyphomycetes described by Ehrenberg in 1818, the Tuberculariaceæ.—R. J. Daniel: Method of staining and cleaning crustacea. Briefly, the method consists in taking small or medium sized crustacea, which have been bleached either by prolonged immersion in alcohol (e.g. museum specimens) or by the use of perhydrol (Merek), and leaving them overnight in a 0.05 per cent. solution of parabenzo-quinone in abso-

lute alcohol. The specimens are then passed through various mixtures of absolute alcohol and methyl-salicylate, and finally cleared in the latter liquid. The muscles are stained red and the rest of the animal is transparent.—I. S. Double: The microscopic characters of certain horizons of the Upper Chalk. The chalk of the eastern counties of England contains 97.99 per cent. of calcium carbonate. The remainder consists mainly of a clay-like substance with a small proportion, less than 0.01 per cent., of detrital mineral grains. Of these, quartz and felspar occur most frequently, a fair number of the quartz grains with diameters of 0.1 mm. to 0.4 mm. being well rounded. Zircon, rutile, mica, tourmaline, and iron oxides are usually present, but kyanite, andalusite, chlorite, sphene, and staurolite are only occasionally present. It is considered that they were wind-blown into the chalk-sea. Very few organic remains are present, the greater part of the chalk consisting of a fine-grained aggregate of calcium carbonate. This is crystalline, for it reacts to polarised light.—R. Ruggles Gates: The meiotic phenomena in pollen development were studied in *Lathræa squamaria* and in *L. clandestina*, an introduced French species. The chromatin behaviour shows only minor differences, both species having 21 pairs of chromosomes. The tapetum is peculiar in being constantly binucleate on one side of the locus and uninucleate on the other. Crystalloids are found in the nucleolus of the pollen mother cell nucleus, and in squizesis the spireme is constantly attached to one or more nucleolar bodies. The spireme does not form a continuous thread but remains a reticulum, in which the chromosomes are formed by flowing together of the chromatin at certain points, producing pairs of chromosomes. The tapetum ultimately becomes plasmodial.—H. E. Hurrell: The ecology of the fresh-water polyzoa in East Anglia. Polyzoa are more abundant in the Norfolk waters than in any other part of the country. This is attributed to the fact that the rivers and broads afford a suitable food supply, namely, diatoms, infusoria, and minute algæ. The rivers Yare, Bure, Thurne, Waveney, and their tributaries are all directly connected with Breydon Water, an estuary of the Yare, 3½ miles by ¾ mile, which is a unique culture bed for the diatoms, algæ, etc. Most of the known British species of fresh-water Polyzoa are found. *Victorella pavidus* has not yet been discovered, although its usual host (the hydrozoan *Cordylophora lacustris*) occurs in the river Thurne in great luxuriance.

(To be continued.)

MANCHESTER.

Literary and Philosophical Society, April 5.—J. Wilfred Jackson: New Carboniferous lamellibranchs, and notes on other forms. The recent re-survey of the coalfields of Lancashire, Yorkshire, and Cumberland by the Geological Survey of Great Britain has provided material for a revision of certain Carboniferous marine lamellibranchs. The collections consist largely of shells belonging to the genera *Pterinopecten*, *Posidonomya*, and *Posidoniella*. These have been studied in association with material from other sources. Several new species of *Pterinopecten*, all previously ascribed to *P. papyraceus* (Sow.), but coming from lower horizons than that species, are described. Three of these species are from the Millstone Grit series, and one is from the horizon of the Lower Bowland Shales. New species of *Posidonomya* and *Posidoniella* are also described and figured from the Millstone Grit series.—S. H. Straw: Fish remains from the Upper Silurian rocks of Ludlow. Dermal studs of *Thelodus* and fragments of "*Scaphaspis truncatus*" are recorded from the Whitcliffe Flags of

Ludlow. The significance of these occurrences is discussed, emphasis being laid on the need for caution in the use of fossil fishes in fixing the base of the Downtonian in other areas, owing to the possibility of their occurrence in greater abundance in pre-Downtonian rocks in regions where physical conditions were more favourable to their existence than in the Ludlow district.—Gerald Andrew: Petrographic notes on specimens in the 'David Forbes' collection of rocks in the Manchester Museum. (1) Two specimens from the collection from Leicestershire are described. The first is a specimen (collected in 1856) from the dyke running across the Mt. Sorrel quarry. It is a fresh rock with peculiarities which differentiate it from the melanocratic igneous rocks of the Midlands, containing uniaxial augite, plagioclase—andesine to labradorite. No olivine is seen. Patches of fine-grained material are sporadically scattered through the rocks, with needles of oligoclase in a base which is sometimes glassy and sometimes consists of plates of an alkaline felspar, probably orthoclase. The rock appears to be a new type of lamprophyre. The second rock is recorded from Whitwick Colliery shaft sinking, and is a fine-grained porphyritic, felsitic variant of the orthophyre described by E. E. Lowe (1926), with cognate orthophyric xenoliths. The precise situation in the shaft section is not recorded.

GENEVA.

Society of Physics and Natural History, Mar. 17.—L. Duparc: An amphibole of the glaucophane group. The author has proved the presence, round a normal glaucophane, of an edging where the n_z and n_m axes are inverted. The plane of the y axes is 90° from that of the normal glaucophane. The name of pseudo-glaucophane is given to this variety.—J. Favre: The presence of *Clyplina jurassica*, a calcareous siphon alga, in the Portlandian at various points of the southern Jura. Although proved present, but not previously determined in the upper Portlandian of the Salée, this alga has been found again by the author in abundance at various points of the southern Jura; it may become a characteristic fossil of the extreme end of the Jurassic.—Eug. Pittard: The weight of the skull and of the encephalon of the Boschimans-Hottentots. Measurements made on 139 skulls from the Cape Town Museum have given averages relatively high for a height so small as that of the Boschimans.

ROME.

Royal Academy of the Lincei, Feb. 20.—P. Vinassa: The constituents of the earth's crust and the molecular number. The majority of the substances constituting the air and the waters, rocks, and organic matter of the earth's crust have even molecular numbers.—A. Russo: The germinative power of the somatic cells of metazoa and metaphytes and recovery of the sexual power of the impure gametogens in *Cryptochilum echini* (Maupas) in relation to the behaviour of the nuclei during the cycle of development.—S. Baglioni and A. Galamini: Physiological action of alcohol (iii). Action on the albino rat during growth, insufficient nutrition, fasting, and subsequent nutrition. Ingestion of 1.3 gm. to 4.6 gm. of ethyl alcohol per kilogram of body weight per day produces no definite effect, either harmful or favourable, on the growth of the albino rat or on its resistance to complete abstinence from food. It seems, however, to favour increase in weight after the cessation of a fast resulting in loss in weight to the extent of 30 per cent. Alcohol also markedly increases the resistance of the rat to an insufficient sub-protein, sub-lipinic, hyper-carbohydrate diet, but diminishes that to a sub-protein, sub-carbohydrate, hyper-lipinic diet.—A. Luigi Herrera: New imitations of amœbæ in motion.

Modification of the procedure previously employed results in the formation of structures resembling amœbæ which develop pseudopods and imitate the movements of the natural amœbæ.—M. Crudeii: The elementary geodetic distance: process of extension of Jacobi's equation to any Riemann variety.—N. Spampinato: New contributions to the general theory of Riemann's matrices.—R. Caccioppoli: Multilinear functionals.—A. Weinstein: A mixed problem for harmonic functions.—J. Dubourdieu: Congruencies of curves.—O. Onicescu: The asymptotic behaviour and the zeros of a class of entire functions.—G. Vranceanu: Geodetic stability. Application to the conservative systems of mechanics.—M. Pascal: The curves which appear in the study of the circuito-translatory current.—U. Barbieri: Determination of absolute azimuth made at Andrate in August 1926.—G. Bozza and G. Devoto: Calculation of chemical affinity on the basis of entropy (ii). The expression previously deduced, permitting of the calculation of the free energy of a chemical process on the basis of the heat of reaction at 298° K., the entropies at 298° of the components in the physical states assured in the equilibrium considered, and the specific heats from 298° to the temperature considered, is applied to a number of reactions. In cases where the available data are trustworthy, the results are satisfactory.—F. P. Mazza and G. Dello Jojo: The rotatory dispersion of certain aspartic esters. It is not certain that, in aqueous or hydrochloric acid solution, aspartic acid has the normal structure, but this is certainly exhibited by the sodium salt and by the dialkyl esters, which are lævo-rotatory. It would therefore appear more rational to indicate by the name *l*-aspartic acid the acid dextro-rotatory in aqueous solution. Dialkyl aspartates show normal optical dispersion, but the mono-alkyl esters present a distinct maximum for the wave-length about 5209 \AA.U. In aqueous solutions of the latter compounds, the α -carboxyl group is probably satisfied by the amino group.—L. Fernandes: Researches on sulphosalts.—A. Pieroni: Some derivatives of pyridine.—M. Cornet: The influence of the hydrogen ion concentration on the respiratory exchanges of the tissues. The results of experiments on the respiratory changes occurring in frog's muscle or liver in phosphate and citrate solutions of different hydrogen ion concentration appear to indicate that the fundamental factor in the maintenance of a high respiratory exchange is a hydrogen ion concentration below the isoelectric point.

VIENNA.

Academy of Sciences, Feb. 10.—E. Rona and E. A. W. Schmidt: Researches on the penetration of polonium into metals. There is no very great penetration, but on lead a surface effect.—A. Kieslinger: Second preliminary report on geological and petrographical researches in the southern Kor Alps (Styria).—A. Kieslinger: Paramorphosis of disthene after the manner of andalusite.—A. Puschin and D. Barara: The equilibrium in binary systems containing cresols as one component.—W. J. Müller: The current density and potential curves of metals showing passivity, illustrated by the example of iron.—A. Kailan and K. Melkus: On esterisation in ethylene glycol.—L. Schmid and M. Zentner: Dehydration experiments with sitosterine.—R. Grüner, Z. Benes, E. Schubert, and M. Arman: Some triazoles and their derivatives.—T. Kisser: Researches on the influence of nutritive salts on the transpiration, water assimilation, relative shoot and root masses and leaf structure (Parts 1 and 2). Experiments with salts of calcium, magnesium, sodium, and potassium on wheat plants show that there are marked contrasts in the effects of calcium and potassium.

Official Publications Received.

BRITISH.

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 20: The Topographical Features of the Granite-Schist Junction in the Leinster Chain. By Anthony Farrington. Pp. 181-192+1 plate. 1s. Vol. 37, Section B, No. 21: Further Records of Collembola from Spitsbergen. (Results of the Oxford University Expeditions to Spitsbergen, 1923 and 1924.) By Dr. George H. Carpenter. Pp. 193-200. *rd.* (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Journal of the Royal Microscopical Society. Series 4, Vol. 47, Part 1, March. Pp. 14+90. (London.) 10s. net.

British Museum (Natural History). Picture Postcards. Set H4: Mediaeval Natural History, Series No. 1. 5 cards in colour. 1s. Set H5: Mediaeval Natural History, Series No. 2. 5 cards in colour. 1s. Set H6: Mediaeval Natural History, Series No. 3. 5 cards in colour. 1s. Set H7: Mediaeval Natural History, Series No. 4. 5 cards in colour. 1s. Set H8: Mediaeval Natural History, Series No. 5. 5 cards in colour. 1s. Set H9: Mediaeval Natural History, Series No. 6. 5 cards in colour. 1s. (London: British Museum (Natural History).)

Queen-land Geographical Journal (New Series); including the Proceedings of the Royal Geographical Society of Australasia. 40th and 41st Sessions, 1924-26. Vols. 40-41. Pp. 1+165. (Brisbane: Royal Geographical Society of Australasia.)

FOREIGN.

Publications of the Astronomical Observatory of the Warsaw University. Vol. 3, Part 1: Determination of Latitude by the Method of Equal Altitudes of Different Stars (Plewzow's Method) and the Corresponding Star-Pairs for Northern Latitudes 20°-40° for the Epoch 1930.0. Vol. 1: Northern Latitudes 20°-25°. Part 1: General Statement. By Prof. M. Kamiński. Pp. 53. (Warsaw.)

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1926. Pp. xxvi+308. (Bern: Paul Haupt.)

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1927. 98^e Année. Pp. 98+178+4 planches. (Bruxelles: Maurice Lambert.)

Proceedings of the United States National Museum. Vol. 69, Art. 14: Classification of the Cheilostomatous Bryozoa. By Ferdinand Canu and Ray S. Bassler. (No. 2640.) Pp. 42+1 plate. Vol. 70, Art. 11: New West American Marine Mollusks. By Paul Bartsch. (No. 2660.) Pp. 86+6 plates. Vol. 70, Art. 15: Generic Names applied to Birds during the Years 1916 to 1922 inclusive, with Additions to Waterhouse's "Index Generum Avium." By Charles W. Richmond. (No. 2664.) Pp. 44. Vol. 71, Art. 5: A new Parasitic Nematode from an unknown Species of Bat. By Benjamin Schwartz. Pp. 4. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Harrap's Reference List of Educational and General Books, including the publications of D. C. Heath and Co. Pp. 94. (London: George G. Harrap and Co., Ltd.)

Analysis of Coal and its By-Products. (Technical Research Series No. 5.) Pp. xvi+136. (London: Baird and Tatlock, Ltd.)

Abbey Mills Papers. Pp. 16. (London: Grosvenor, Chater and Co., Ltd.)

Catalogue of Books on Natural History. (No. 215.) Pp. 98. (Edinburgh: James Thin.)

Union-Castle Continental Holiday Cruises. Pp. 12. Holiday Tours to Madeira or Canary Islands. Pp. 8. (London: The Union-Castle Mail Steamship Co., Ltd.)

Diary of Societies.

SATURDAY, MAY 21.

ROYAL SANITARY INSTITUTE (at Guildhall, Bath), at 10.30 A.M.—F. P. v. Sissons: Sewage Disposal.

MONDAY, MAY 22.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Prof. W. H. Hobbs: The University of Michigan Expedition to Greenland in 1926 and Plans for the Continuation of the Work during the Coming Season.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons of England), at 5.30.—Sir Berkeley Moynihan: Address.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. J. Davis: The Moorish Architecture in Northern Africa (Lecture).

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. C. Singer: The Mediaeval Aristotle.

TUESDAY, MAY 23.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the Month of April 1927.—H. A. Harris: The Skull Form and Dentition of the Primates.—W. N. F. Woodland: A Revised Classification of the Tetraphyllidean Cestoda, with Descriptions of some Phyllobothriidae from Plymouth.—Daphne Aubertin: On the Anatomy of the Land Snails (*Helicidae*) *Cepaea hortensis* Muller and *Cepaea nemoralis* Linn.

JUNIOR INSTITUTION OF ENGINEERS (at Showrooms of Holophane, Ltd., Westminster), at 7.—Stage and Colour Lighting (Lecture and Demonstration).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—H. M. Cartwright and F. J. Tritton: Inherent Fog in Photogravure and a Method for its Elimination.—Dr. F. M. Hamer and O. Bloch: The Optical and Photographic Properties of a Series of Typical Cyanine Dyes.

ROYAL ANTHROPOLOGICAL INSTITUTE (Conversation at the Wellcome Historical Medical Museum, 54A Wigmore Street, W.), at 8.30.—Prof. Elliot Smith: The Medical and Magical Aspects of the Anthropological Material in the Museum.

WEDNESDAY, MAY 25.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section) (Annual General Meeting), at 5.—Dr. M. J. Rowlands: Rheumatoid Arthritis: Is it a Deficiency Disease?

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. F. S. Wallis: The Old Red Sandstone of the Bristol District.—Sir Arthur Smith Woodward, on behalf of Prof. Sampat Iyengar: Exhibition and Description of Photographs of a Cretaceous Reptilian Vertebra from Southern India.

BRITISH PSYCHOLOGICAL SOCIETY (at Royal Anthropological Institute), at 8.15.—Dr. E. Hamilton Wild: The Influence of Conation on Cognition.—Dr. A. C. Garnett: A Conative Criterion for the Discrimination of Types of Instinctive Behaviour.

THURSDAY, MAY 26.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (East Midland District Meeting) (at Town Hall, Ilkeston), at 10.45 A.M.

BRITISH SCIENCE GUILD (Annual Meeting) (at Royal Society of Art-), at 8.30.

ROYAL SOCIETY, at 4.30.—Helga Pearson: On the Skulls of Early Tertiary Suids, together with an Account of the Otic Region in some other Primitive Artiodactyla.—A. W. Greenwood and Dr. F. A. E. Crew: Studies on the Relation of Gonadic Structure to Plumage Characterisation in the Domestic Powl. II. The Developmental Capou and Poularde.—Dr. F. A. E. Crew: The Laying Hen with Cock's Plumage Part III.—Dr. E. J. Salisbury: On the Causes and Ecological Significance of Stomatol Frequency, with special reference to the Woodland Flora.—J. W. Trevan: The Error of Determination of Toxicity.—C. K. Brinker and E. D. Churhill: A Graphite Suspension for Intravital Injection of Capillaries.—Dr. F. W. R. Brambell: The Development and Morphology of the Gonads of the Mouse Part I. The Morphogenesis of the Indifferent Gonad and of the Ovary.—Dr. A. S. Parkes: On the Occurrences of the Oestrus Cycle after X-Ray Sterilisation. III. The Periodicity of Oestrus after Sterilisation of the Adult.

FRIDAY, MAY 27.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Annual General Meeting), at 5.—Dr. J. D. Rolleston: The Section and its Work, 1905-1926 (Presidential Address).

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Demonstration: The Production of Splashes by Electric Discharge, by G. L. Addenbrooke.—Communications.—Dr. Ezer Griffiths and E. Griffiths: A Duplex Reversal Key with Mercury Contacts.—L. Hartshorn: The Measurement of the Inductances of Four-terminal Resistance Standards.—Dr. C. Chree: Magnetic Disturbances and Aurora as observed by the Australian Antarctic Expedition at Cape Denison in 1912 and 1913.—K. R. Rao: Series in the Spectrum of Trebly-ionised Tin (Sn. IV).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Dr. W. S. C. Copeman: The Prophylaxis of Measles, with a Suggested Scheme for Dealing with Epidemics.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB, at 8.15.—F. E. Smith: Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—H.E. the Marquis de Merry Del Val: Gabriel y Galan, Contemporary Spanish Poet (with Quotations in Spanish).

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District Meeting) (at Newport).

SATURDAY, MAY 28.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Armstrong: Variable Speed Gears and their Application for Colliery Purposes.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District Meeting) (at Newport).

PUBLIC LECTURES.

SUNDAY, MAY 22.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Miss Margaret Murray: Ancient Egypt.

MONDAY, MAY 23.

UNIVERSITY COLLEGE, at 5.30.—R. Johnson: Lord Lister and the Romance of Surgery (only for the members of University College and Medical School).

THURSDAY, MAY 26.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries in Palestine: The City of Gerar.—At 5.—Prof. H. Maclean: Insulin in the Treatment of Diabetes and Some Other Nutritional Disturbances.

SUNDAY, MAY 29.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Prof. J. Garstang: Recent Discoveries in Palestine.

CONGRESSES.

MAY 25 AND 26.

FRENCH SOCIETY OF OTO-NEURO-OPTHALMOLOGY (at Strasbourg).

JUNE 6 TO 9.

CONVENTION OF CANADIAN CHEMISTS (at Quebec).



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Remaining Possibilities of Water-borne Diseases.

THE greatest public health triumph of the last half-century has been the almost complete conquest over water-borne infections. In Great Britain the chief of these is enteric or typhoid fever; and the reduction of the death-rate from this disease in England and Wales from 332 per million of population in the average experience of 1871-80 to 25 per million in the average experience of 1921-25, shows that this disease is following typhus fever and becoming a disease of rare occurrence in the country. Although reduction of personal infection by better nursing and hospital treatment, the increased protection of foods which, like oysters, are eaten raw, and the help which bacteriology has given in securing prompt diagnosis of enteric disease in 'carriers' as well as in clinical cases of the disease, have all borne an important part in bringing about this remarkable result, the chief factor has been the protection of the public water supplies of Great Britain.¹

The substitution of supplies controlled by municipalities or by large commercial companies for smaller supplies inadequately protected has formed an important element in securing clean water. Although when accidental contamination occurs—as in the historical Maidstone and Worthing epidemics of enteric fever—the unification of water supplies for large communities may imply widespread disease, the standard of precautions has steadily improved, and the communal supply of water by a single authority in each area has been the chief means for protecting the communities concerned by means of safe drinking water.

A very large part of the total drinking water supplied in England is derived from rivers; and its protection necessarily implies serious difficulties. Of the two alternatives, that of keeping the water pure and that of purifying it after contamination so as to render it safe for drinking, the first is obviously preferable; but in most modern communities this is impracticable to the extent which would obviate the need for supplemental purification. In this connexion much interest attaches to the report of a deputation which waited on the Earl of Balfour (on behalf of the Prime Minister) on Feb. 15 last. This deputation represented the British Waterworks Association and the Salmon and Trout Association, and it urged on the Government the need for the creation of a national co-ordinating authority with powers to set up rivers- and watershed boards for all rivers in England and Wales.

This was urged in view of the risks to health of the increasing volume of river pollution, the threat to fish life, and the impairment of the beauty of the country caused by the increasing volume of pollution of our rivers. The facts are not in dispute. There is perhaps ample law to enable pollution of rivers to be controlled; but responsible authorities are inert, or fail to co-operate.

Lord Balfour's reply to the deputation took in part the form of most pertinent queries and showed the difficulties of the problem. Is the proposed central authority to have executive powers, and how are these to be related to those of existing authorities? Leaving administration for science, Lord Balfour pointed out that the essence of the problem consists in the purification of effluents before they are discharged into streams. It is evident that rivers inevitably must act both as sources of water supplies and as recipients both of domestic sewage and industrial waste products. The danger that domestic sewage will cause infectious diseases, and the effect of trade effluents on fish life, form two separate problems, of which the former can be much more easily controlled. As regards trade effluents, there must always be involved a balanced consideration of the expense of complete purification and of the loss implied—to fish life and to æsthetics—in neglecting it.

The deputation should, however, do good. Research has generally shown that purification of effluents is economical to the manufacturer as well as beneficial to the public; there is already in many instances adequate knowledge to secure purification; and the pressure of public opinion as well as the utilisation of existing powers is called for to secure the adoption of measures of purification now feasible.

London is the greatest example in the world of a public water supply derived chiefly from sewage-contaminated rivers, which for many years has been distributed daily to several million people without any serious outbreak of enteric fever or cholera attributable to it. This has occurred during a long series of years, in which chief dependence has been placed on sand filtration of the crude river water, and more recently on additional prolonged storage in large reservoirs; and it is a great tribute to the large London water companies in the later years of their experience, and to their still more efficient single successor, the Metropolitan Water Board, that this gigantic experiment on human beings has been so uniformly free from ill results. Under the guidance of Sir Alexander Houston the last-named Board has steadily increased the use of

an additional safeguard, and now about 76 million gallons of Thames water are chlorinated daily. Since 1916 some 2 millions of people have daily drunk this water after filtration without detecting any difference in its taste. Without entering into detail, it is interesting to note the statement made by Sir Alexander in the twentieth annual report of the Metropolitan Water Board that, judged by bacteriological quality of the water supplied to London, "it would be safer to drink 1000 fluid ounces or fifty pints of some of the stored waters than one fluid ounce of the raw river water antecedent to storage."

The steadily favourable experience of the metropolis has some bearing on a report by Dr. Hancock just issued by the Ministry of Health on an outbreak of illness at Poplar suspected to be due to local pollution of the water supply. The illness in question was diarrhoea associated with fever, and between July 11 and 12, 114 cases occurred, and probably many more. Foods, including milk, were excluded, as the result of investigation on well-known lines, as possible causes of the outbreak, and suspicion turned to water as a possible vehicle of infection. The water in the implicated area gave unsatisfactory bacteriological results; and investigation showed that in the special area implicated in the "veritably devastating" local outbreak there existed a complex arrangement of water pipes, those of the local gas works being supplied in part from the River Lea, opposite the gas works, which in this locality is heavily polluted. It is possible that some of this contaminated water had by reflux got into the water mains of the district and thus caused a serious outbreak of illness. Actual proof that such inter-communication of pure and contaminated water had occurred could not be obtained; but the cross pipes have been disconnected, and the report has a high value in directing attention to the possible dangers attaching to such arrangements.

Some interest attaches to the bacteriological side of the investigation. No dysentery-like bacilli were identified and agglutinin tests were negative; but, as is pointed out by Dr. W. M. Scott in a supplementary report, a similar experience occurred recently in Hanover. In the Hanover experience a serious typhoid outbreak followed; fortunately this was escaped in Poplar.

The report should be studied by health officers and water engineers; and it reminds us once more that the price of immunity from water infection is uninterrupted vigilance both on the engineering and the chemical side of public health.

The Mechanism of Gaseous Reactions.

The Kinetics of Chemical Change in Gaseous Systems. By C. N. Hinshelwood. Pp. 204. (Oxford: Clarendon Press; London: Oxford University Press, 1926.) 12s. 6d. net.

MR. HINSHELWOOD'S book provides an opportunity for the general reader to make himself acquainted with a branch of chemistry which is developing rapidly at the present time, but of which the importance may not be appreciated by those who do not profess and call themselves physical chemists. These new developments may be summed up in the term 'activation.'

This conception has been introduced in order to account for the slowness of chemical change, and in particular for the fact that molecules which are capable of dissociating or of undergoing isomeric change do not do so all at the same time, and immediately, giving rise to instantaneous reactions. This delay can sometimes be traced to the fact that the action is conditioned by association with some foreign substance, *e.g.* moisture, and that the molecules which wish to undergo change have, as it were, to form a queue and take their turn in receiving the necessary dispensation from the appropriate official; but since even the wettest and dirtiest materials do not change instantaneously, there must be some condition of 'activation' within the molecule itself which is a necessary precedent to chemical change. An exception to this rule is found in ionic double decompositions, where the ions behave as if they were already activated, and therefore interact as fast as they can come into contact with one another. It is therefore an attractive proposition to associate reactivity with a condition analogous to ionisation, and for this view there is considerable justification in the case of actions which take place in liquid media. But in the case of gaseous reactions, at least, it is probably more to the point to think of activation in terms of energy, and to regard an activated molecule as one which contains a larger supply of energy than its inactive neighbours, since, when once this reserve of energy is created, it can be drawn upon to overcome whatever obstacles may be found to impede the progress of chemical change.

Physical chemists claim, however, not only to know of the existence of this process of activation, but also to be able to give a numerical estimate of the degree of excitement which precedes chemical changes of the most diverse character. The most familiar method is to deduce a value for the heat

of activation from the effect of temperature on the velocity of the reaction. The relationship which Arrhenius used for this purpose is expressed by the formula,

$$d \log k/dT = A/RT^2,$$

where A is the 'heat of activation' and k is the velocity coefficient at temperature T° abs. This is almost identical with Van 't Hoff's formula,

$$d \log K/dT = Q/RT^2,$$

whereby the heat of a reversible reaction Q can be deduced from the variation of the equilibrium-constant K with temperature; but whereas Van 't Hoff's formula depends on strict thermodynamical reasoning, and can be tested by direct experiment, Arrhenius's formula is necessarily of a more speculative character, since the hypothetical heats of activation to which it leads cannot be measured by any direct process.

The validity of the formula finds some support, however, in the fact that a very accurate linear relationship is revealed in a large number of cases when $\log k$ is plotted against $1/T$. When this relation holds good, as in the decomposition of hydrogen iodide into hydrogen and iodine, or the thermal decomposition of ammonia in contact with a tungsten filament, one is tempted to believe that the 'heat of activation' deduced from it may perhaps represent a real physical property. A similar statement can be made in reference to those cases in which this method of plotting gives rise to two straight lines with a rounded intersection. This characteristic is observed in the union of hydrogen and sulphur, which Norrish and Rideal formulate as depending, in the lower ranges of temperature, mainly on an interaction at the surface of liquid sulphur, and, at higher temperatures, mainly on an interaction in the gaseous phase.

The chief interest of Mr. Hinshelwood's book is to be found in his description of a second method for determining the energy of activation. This is limited to gaseous reactions, but has a much stronger theoretical basis than the somewhat speculative relationship of Arrhenius. It depends on calculating, by means of the kinetic theory of gases, the number of collisions which take place in unit time between the molecules of a gas, and then comparing this with the actual number of molecules which undergo chemical change in the same unit of time. This calculation shows that in a number of typical bimolecular reactions only a minute fraction of the total number of collisions is effective in producing chemical change. The next step is to calculate from the probability law

what excess of energy the reactive molecules must be supposed to contain in order that it may be possessed only by this minute fraction of the total number of molecules. The excess of energy thus postulated is taken as the heat of activation of the bimolecular reaction.

The data for the decomposition of hydrogen iodide provide a coincidence between the values calculated in this way and those deduced from Arrhenius's formula, which can only be accidental, since it is obviously far more exact than the experimental methods on which it is based. In this case the two values for the energy of activation are 43,900 and 44,000 cal., and the calculated velocity coefficient, 3.5×10^{-7} at 556° abs., is therefore practically identical with the observed coefficient, 3.52×10^{-7} . A more typical case is that of the union of hydrogen and iodine, where the calculated velocity constant at 700° is 0.14, whilst the experimental value is 0.064. This is claimed as "a very good agreement" in view of the fact that, since the two methods of deducing the energy of activation are entirely independent, the calculated velocity coefficient might very well be 10,000 times larger or smaller than the experimental value if the theory now put forward were incorrect.

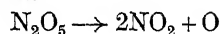
The method described above is particularly applicable to the study of bimolecular actions, which obviously depend in the first instance upon collisions taking place between appropriate pairs of molecules. In several of these cases it has been established clearly that the majority of the collisions are ineffective and result only in the rebound of unchanged molecules from one another; moreover, a quantitative interpretation of the phenomena can be given by supposing that the effective collisions are those which take place between molecules possessing a high energy content. The general reader may, however, be surprised to learn that when two atoms of bromine meet, the collision is ineffective in 999 cases out of 1000. It is difficult to admit that the two free atoms are insufficiently energised to combine, although this conclusion is not completely excluded; but the quantum theory allows us to suppose that in many cases the fundamental difficulty is to get rid of the energy which the atoms already possess, and it is clear that a molecule from which this energy had not yet been dissipated would be liable to break up again on the slightest provocation.

The study of unimolecular reactions is much more difficult, since, if only a single molecule is really involved in the change, there is at first sight

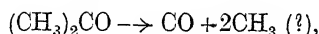
no obvious reason why the change should depend on collisions at all. It is not surprising, therefore, that there has been an energetic controversy proceeding for several years as to the mechanism of the action. Mr. Hinshelwood defines a unimolecular action as one in which the proportion of molecules undergoing change in a given time is independent of the pressure. Perrin has assumed that this law still holds good at infinite dilution, and that isolated molecules in interstellar space would have the same average life as in a closed vessel. Since this life depends on the temperature, but by hypothesis is independent of collisions with other molecules, as well as of the unknown velocity of the molecules in absolute space, Perrin and Lewis have postulated that the chemical change is due to radiation, and that its velocity is dependent on the 'radiation-density' in the space which contains the gas. This hypothesis leads to such wildly impossible conclusions (as, for example, that an aqueous solution of a sugar should be hydrolysed with explosive velocity when exposed to the dazzling light of a tallow candle) that its survival in any form is a thing to be marvelled at.

In order to avoid these grotesque conclusions, Lindemann has recently put forward an alternative theory, in which collisions play an essential part, and give rise to a definite proportion of activated molecules. The velocity of reaction must then fall off at extreme dilution, but calculation has shown, in the particular case of nitrogen peroxide (see below), that even when the pressure is reduced to 0.01 mm., the number of collisions is still far greater than the minimum number required to activate the molecules which undergo chemical change under these conditions; it is therefore impossible to make a direct test of the two alternative views at present. Mr. Hinshelwood has, however, recently described two thermal decompositions, taking place at much higher temperatures, in which a 'unimolecular' action is retarded on reducing the pressure, in accordance with Lindemann's postulates.

Most of the work on unimolecular actions has been built upon imaginary cases. Thus, when Perrin and Lewis put forward their explanation of these actions, no single case was known which has survived later criticism, since all the examples that were then cited have been proved to take place at the surface of the containing vessel and not in the interior of the gas. After much searching, the solitary case of the decomposition of nitrogen pentoxide



has emerged, as being independent of the area of the surface of the vessel, and of the pressure of the gas down to 0.01 mm.; and Mr. Hinshelwood himself has recently added to this exiguous list the thermal decomposition of acetone

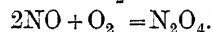
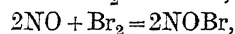
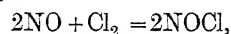


and of the isomeric propionaldehyde; but these are queer reactions which cannot yet be represented by chemical equations, since the nature of the products is unknown, although they are obviously complex.

In all these discussions the eminent president of the Chemical Society stands in the background in the unpleasant rôle of the spectre at the feast, since, if it be true that chemical change in simple systems generally (and perhaps always) depends upon the presence of moisture, what are we to think of speculations in which so essential a factor is ignored? The quantities of moisture that are involved are now becoming known in certain cases, and they correspond very well with those required to produce a unimolecular film on the surface of the containing vessels. Norrish has therefore put forward the bold but fascinating hypothesis that, in the particular case of hydrogen and chlorine, the formation of a water-film on the surface of the vessel is a necessary precedent to the occurrence of chemical change in the interior of the gas. This hypothesis may not be true, but it has at least the merit of assigning a plausible rôle to the water in changes in which it plays a vital part, as well as to the various agents, such as ammonia, by which its action may be inhibited. In the cases now under consideration, it is claimed that "the observed rates of reaction are constant and reproducible, whether the gases have been dried carefully or not," and that "in no homogeneous reaction which proceeds with measurable and reproducible velocity has the inhibition by drying been demonstrated" (p. 103); but the outside observer, remembering the difficulties that have been experienced in the past by those who have tried merely to repeat the published work of H. B. Baker, will probably remain unconvinced by statements of this kind, until Baker himself has announced that he has tried to arrest these reactions and failed.

Termolecular reactions are almost as rare as genuinely unimolecular reactions, since many of those which are represented conventionally as an interaction of three molecules, either proceed in two successive stages or take place at the surface instead of in the interior of the interacting gases.

Up to the present three such cases have survived criticism, namely:



The most remarkable feature of the last action is that it has a negative temperature coefficient, the interaction at 662° abs. being three times slower than at 273° abs. This is accounted for by the fact that "owing to the increasing molecular speeds there is less and less chance, at great temperatures, that two molecules shall still be within range of each other when a third one approaches. It is to be noted that the velocity of reaction falls off only very slowly, so that the diminishing frequency can account for the retrogression without undue strain" (p. 111).

About one-third of the book is occupied with a description of heterogeneous reactions, but these are less uniquely the province of the author, and it will therefore suffice to say that all the main problems of the effects of adsorption, of molecular orientation, and of the texture of the catalytically active surface are discussed in a clear and satisfactory manner. In conclusion, it should be added that whilst the whole book has a definite mathematical basis, it can be read with profit by those whose ignorance of mathematics, or lack of interest in the details of mathematical processes, compel them to practice the gentle art of skipping. The book has, in fact, been written by a chemist for the benefit of other chemists, and the author's mathematical deductions are treated throughout as a means to an end and not as a final goal.

The Theory of Perception.

An Introduction to the Theory of Perception. By Sir John Herbert Parsons. (The Cambridge Physiological Library.) Pp. viii + 254. (Cambridge: At the University Press, 1927.) 18s. net.

THE continuity of race of the present fauna of the earth is due to many different factors. In the case of what we call the higher animals—slow-breeding, exposed to the attack of many sorts of enemies, in some cases subsisting on many forms of prey—accurate choice of reaction in each of a multitude of different circumstances has been, and is, a prime factor in the maintenance of race. Even where the choice of reaction may be limited, as between attack, flight, and no action at all, the determination of choice may be complicated; for the numbers of objects to which the choice is to be applied may be almost infinite.

While the primary reactions (such as those mentioned above) may be classified with comparative simplicity, each individual reaction has to be modified in 'countless ways in accord with the variety of the object. Such ways may be briefly indicated by the expressions 'mode of attack' and 'direction of flight.' In man, the biological value of team-work has been given effect to by a great development of the mechanism of spoken-speech and heard-speech; and man probably alone of all animals is able to convey to a comrade an accurate description of the objects and changes which he observes in his immediate or distant surroundings. His behaviour, both as an individual and as a member of a team, depends, as do the reactions of other animals, upon the distinguishing of differences in the surrounding environment.

Sir John Herbert Parsons compresses into scarcely 250 pages a wealth of information with regard to the perception of phenomena. To him, as to Lloyd Morgan, the progress of evolution from the more simple to the more complex is accompanied at various points by the 'creation' of new developments. It is a creed of emergent evolution, which he uses as a scientific method. In its light, the property of water is an emergent which could not have been foretold from the properties of the hydrogen and oxygen which combine to form it. There are many levels of emergence, and many sub-levels, within the main line. 'Effective consciousness'—that which enables the animal to guide its actions in the light of previous experience and to exercise choice—is one such emergent.

Consciousness involves a subject and an object. The object is a sensory presentation. The sensory presentation is brought about by stimulation of receptor end-organs, and the conscious subject is aware of this stimulation. The author supposes that the simplest form of consciousness is a mere sentiency—an awareness tinged with affective tone, with a minimum of cognition, and possessing a primitive meaning, and that the subject responds with an appropriate motor reaction—"consciousness on the reflex plane." By further differentiation and integration 'awareness' leads to 'interest'; 'affective tone' emerges in 'emotion'—"consciousness on the plane of instinct." Yet further differentiations and integrations by means of memory and association give the emergence of higher ideation and conceptual consciousness—"consciousness on the plane of intelligence." At every level the object of a sensory presentation has to pass through the entry enforced by the

receptor organ, and differentiation of receptors—and of the whole receptor mechanism—plays a chief part in analysing the properties of the object. A consideration of data from many sources—general morphology, animal psychology, morphology of the peripheral and central nervous systems, the physiology of reflex phenomena, and observation in man—leads the author to maintain the following thesis:

Primitive sentiency is essentially tactile. At higher levels response to radiations emerges and specific receptor organs of many varieties evolve. Parallel with this evolution there is an evolution in the complexity of the central nervous system—with the development and dominance of the segments at the anterior end of the axially arranged animal, and the elaboration there of central ganglia for the distance receptors so clearly emphasised by Sir Charles Sherrington. An evolution in perception and in consciousness parallels these morphological evolutions. On the physiological side, reflex action emerges from less differentiated response; and it is inferred that the afferent impulse arouses a vague sentience analysable into two parts—into the germ of affective state and into the germ of cognitive state. The instinctive plane is an emergent from the reflex plane. There is a concomitant complexity of conscious experience, an integration without complete synthesis. Before the instinctive act occurs there is an unfocussed affective state—'coenæsthesia'—which acts as a background, and is derived from all the receptors then in activity. Upon this background emotion impinges "like a splash of vivid colour." The more discriminative reactions of the higher vertebrates are emergent from this instinctive level.

In consonance with Sir Charles Sherrington's use of the term 'receptor,' the author suggests 'reception' and 'recept' for the act of sensing and the object sensed. Perception consists for him in the integration of receipts. Differentiation, segregation, and integration result in the emergence of a perception, which is not a mere summation of sensations. The latter "have been integrated into patterns, in which the whole is greater than the sum of its parts; something new has emerged in consciousness." The recept is more differentiated the higher we go in the scale of evolution and concomitantly with the differentiation of receptors. At the primitive level it is dyscric—having little differentiation and little discrimination. The constellation of receipts there merely gives a change in potential in the primitive stream of consciousness. The affective tone becomes more

pleasant or more unpleasant, and the motor response is correspondingly a mass reaction. In a higher level of evolution, the epicritic stage, differentiation of receipts is made possible by differentiation of receptor mechanisms. The receipts form a perceptual pattern of such a differentiation that the diverse sensations are discriminated. Awareness is focussed upon the features of the pattern and becomes attention. At still higher levels, the syncritic stage, epicritic phenomena are integrated by the cortex cerebri; attention becomes interest and 'meaning' emerges in the perceptual pattern. The primitive dyscric mass reaction becomes correspondingly differentiated. The perceptual pattern, at first "a buzzing, blooming confusion" accompanied by an awareness, becomes differentiated as the scale is ascended; its higher development is due to a double process—on one hand of differentiation and reintegration, on the other hand of sensitisation from higher levels which have evolved contemporaneously. In the higher stages the perceptual pattern comes more under the control of higher nervous centres. One or other modality of sensation becomes prepotent, the prepotent modalities being those of the distance receptors—smell, sight, hearing. But throughout there persists a dual mechanism in sensation, the dyscric and the epicritic both persisting.

Such a brief account of the author's 'background' can give no indication of the wealth of vivid evidence from many fields which it serves, or of the facility of his presentation. Excellent and valuable accounts are given of the comparative anatomy of the central nervous system, of cutaneous sensation, of the dyscric motor response, posture and attitude, of perception of space and of perception of movement. But the book will be valued not least for the author's description, in the chapters on vision, of the distance receptor which he has made his own more particular field; for, as Sir Herbert Parsons says, vision is the preponderant modality in man, and has undergone in him the greatest differentiation. T. GRAHAM BROWN.

Siberian Bronze Age Cultures.

Bronzezeit am Jenissei: ein Beitrag zur Urgeschichte Sibiriens. Von Gero v. Merhart. Pp. 190 + 12 Tafeln. (Wien: Anton Schroll und Co., 1926.) 12s.

A BRIEF but very interesting account of the Bronze Age cultures of the Minussinsk area, and a review of the literature on the subject, is given in the work under notice; the author has

also some rather revolutionary ideas to put forward. The region is one of peculiar interest, lying as it does far up the Yenisei valley and forming an island of steppe country cut off on three sides from intercourse with the rest of the prehistoric world, for to the south lie mountains and to the east and west were formerly forest lands. To the north, however, lay a natural east-west passage-way formed by the more or less connecting river systems of the Obi, Ket and Angara leading to Lake Baikal. The author stresses the contention that the early Bronze cultures of the district owe nothing directly to the west, i.e. to the Bronze cultures of the Ural mountains, though both may originally have had a common source. He believes that it was not until very late that any western connexion was established, and that similarities in the two cultures can then be explained by a parallel reception of Scythian influences.

To the reader it is not quite clear from exactly where the author would like to derive the people whose industries he is describing. South, east, and west being blocked, as already described, they must have arrived as a back-wash from the north, following the Yenisei southwards, but where they originally came from seems uncertain. Having settled, however, in this blind-alley district, it would appear that a slow development took place which was at first little influenced from outside owing to the peculiar geographical position of the area. A very late chronology is adopted; in fact round about 600 B.C. is given as a mean date for the full Bronze culture here.

The chapters devoted to a description of the finds themselves are very interesting, and the illustrations quite adequate. An earlier and a later type of grave (called respectively 'corner stone' and 'collective' graves) are described, from which it would appear that an outside influence must have penetrated the region, but not a new race, as many of the old characteristics continue in the new graves. Finds unconnected with burials are also discussed. Of these the Krasnojarsk celt is the most important, and its distribution problems are very complex. Several chapters are devoted to typological study and decoration motifs.

The only regret one has when putting this book down is that the author has kept so rigidly to the period under review. One would like to have known what he thinks existed before the first culture with which he is concerned. Again, there are rock engravings not so far off from his region, some of which are probably of late date, but others

may be very early indeed. A brief mention of them would have been welcome.

The book is very interesting, deals with a little-known but important area, and the author is to be congratulated upon having tackled his subject in a systematic and scientific manner.

M. C. BURKITT.

Our Bookshelf.

The Whitworth Book. Prepared by the Whitworth Society (an Association of Whitworth Scholars, Exhibitioners, and Prizemen). Honorary Editor, Prof. David Allan Low. Pp. vii + 316. (London: Longmans, Green and Co., Ltd., 1926.) 10s. 6d. net.

THE career of Sir Joseph Whitworth, one of the greatest engineers of his time, is especially interesting, since he was the first man to grapple successfully with the problem of obtaining precision of workmanship and the standardisation of screw threads.

It is difficult to realise now that, when he began work rather more than one hundred years ago, it was exceptional to find men able to make parts of machines to an accuracy of one thirty-second of an inch. His epoch-making discovery of a method of making a true plane by a process of scraping and comparing three plates together made it at once possible for engineers to produce work of the utmost precision. This was followed by the manufacture of very accurate screws and the construction of workshop machines to measure lengths to one ten-thousandth of an inch. Indeed, Whitworth was successful in constructing a machine capable of detecting a difference of one millionth of an inch. His surface plates, gauges, and measuring machines soon became established in all engineering workshops and revolutionised their practice, while his machine tools were admittedly unsurpassed.

Although others had attempted the standardisation of screw threads, no one had been able to effect this until Whitworth took the matter in hand and, by adopting the best features of existing systems, brought about an agreement which has received world-wide recognition. In his later years Whitworth was equally successful in improving the manufacture of rifles, large calibre guns, and fluid-compressed steel.

Whitworth's practical mind also realised the necessity to the engineering industry of a continuous supply of young engineers who, in addition to workshop experience, were thoroughly conversant with applied science. Having acquired a large fortune in his manufacturing career, he was able to put his ideas into practice by setting aside £3000 a year for scholarships, and at his death £100,000 was handed over to the State to carry on the scheme associated with his name.

The Whitworth Book is the "Who's Who" of about one thousand Whitworth Scholars appointed under this munificent scheme. Its pages show

how vast an effect this scheme has had on modern engineering in every direction of activity. Probably no engineering work of this great man has been more successful than this final one. The Whitworth Society, and especially the honorary editor, are to be congratulated on having produced a very interesting work of permanent value.

E. G. C.

History of the Sciences in Greco-Roman Antiquity.

By Prof. Arnold Reymond. Translated by Ruth Gheury de Bray. Pp. x + 245. (London: Methuen and Co., Ltd., 1927.) 7s. 6d. net.

PROF. REYMOND begins his volume—the outcome of lectures before both science and arts students at Neuchâtel—by outlining the scientific attainments of the Egyptians and Chaldeans prior to the epoch with which he is mainly concerned. He divides the rest of the book into two parts.

Part I. gives a historical and biographical survey of the development of the sciences during the Hellenic (650–300 B.C.), Alexandrian (300 B.C.–A.D. 100), and Roman (A.D. 100–600) periods. Part II. deals with the principles and methods, and traces the development and characteristics of Greek mathematics and mechanics. The works of Euclid and Archimedes are ably discussed, especially from the point of view of their indebtedness to predecessors.

Whilst these sciences were well developed, others remained almost neglected. Chemical knowledge was practically confined to the preparation of a few salts, extraction of minerals, mixing of paints and concocting drugs. Medicine and surgery were, however, systematically practised and reached a high degree of perfection, as indicated by the comprehensive set of instruments discovered at Pompeii. Aristotle had established a scientific basis for natural history, introducing a classification founded largely on his own observations. His pupil, Theophrastus, catalogued more than 500 plants.

It may be noted how Greek science, first centred at Athens, finally flourished on the periphery of the Hellenic world, especially under the Ptolemies at Alexandria.

Prof. Reymond has dealt with every phase of the teachings of the different schools of the sciences in Greco-Roman antiquity, and students of the history of science will be grateful for this translation of his work.

J. G. F. DRUCE.

Citrus Growing in South Africa. By R. A. Davis.

Pp. 309. (Cape Town and Johannesburg: The Specialty Press of South Africa, Ltd.; London: L. Reeve and Co., Ltd.) 25s. net.

THIS work begins with a brief foreword by the author, in the course of which he suggests that the time appears to be favourable for the publication of such information as the book contains, because, he avers, "Citrus and, especially, Orange growing is 'booming,' and there are many thousands of new-comers to South Africa who are bent on Citrus culture as a means of livelihood." The introduction of citrus fruits into South Africa is

dealt with in Chap. i. It seems somewhat indefinite as to when they were first introduced; but oranges, lemons, and citrons are known to have existed so early as 1662, in the garden of the founder (Van Riebeeck) of the first Dutch Colony, Cape of Good Hope, in 1652. The 'bitter Seville orange' and the ordinary 'rough lemon' have run wild in parts; both are used for stocks for grafting purposes, the 'rough lemon' (called 'Mazoe lemon'—the banks of the Mazoe River being in places lined with the trees) is described in Chap. v. on "Stocks for the Orange" as being the most widely used stock in South Africa.

As an industry, citrus cultivation, from comparatively small beginnings, dates from about 1907, until at the present time the productive area in the Union is estimated to cover about 25,000 acres, the exports including grape-fruit, *naartjes* (mandarin and tangerine oranges), and lemons.

Throughout the course of the whole twenty-six chapters the author has given a very complete record of the progress of production, based on scientific principles in developing the best varieties, the best methods of grading and packing of the fruit for export, and advice in the treatment of fungus diseases and insect pests. J. H. H.

Byways of the Tropic Seas: Wanderings among the Solomons and in the Malay Archipelago. By Hermann Norden. Pp. 250+30 plates. (London: H. F. and G. Witherby, 1926.) 16s. net.

MR. HERMAN NORDEN, already well known as the author of several books of travel, here records his impressions of a voyage to the Solomon Islands and thence to the island of Bali, that fascinating dependency of Java. Of the Solomon Islands he has nothing to say that is of moment to either the geographer or the anthropologist. His story depends for its interest upon his lively sketches of the sailors, traders, and natives whom he met. He gives a vivid enough picture of their life and the experiences which are likely to befall any one who makes a voyage among the islands in a small trading vessel. His account of Bali and its people, though somewhat superficial and new only in an impressionistic sense rather than as a record of fact, covers ground less known than the Solomons and will repay perusal by those who have neither the time nor the opportunity to read more serious treatises on the very distinctive culture of the island.

Mr. Norden was fortunate enough to see some of the principal ceremonials in the life of the Balinese, and describes the rites of their peculiarly modified form of Buddhism, including the *mudras*—the ceremonial gestures which have been carefully described in detail in a graphic style by Miss de Kleen—their cremations, their dances, their shadow puppet plays, and other features of their culture. Unfortunately, on the occasions when Mr. Norden ventures outside what he has actually seen, his statements are seldom free from error in anthropological matters. It surprises to find Polynesian and Melanesian alike described as "Aryan."

The Bryant and May Museum of Fire-Making Appliances: Catalogue of the Exhibits. Compiled, with an Introduction and Notes, by Miller Christy. Pp. viii+192+33 plates. (London: Bryant and May, Ltd.; Simpkin, Marshall and Co., Ltd., 1926.) 5s. net.

AN addition of a novel character to the museums of Great Britain has been made recently in the form of one devoted entirely to fire-making appliances. Fire making is of vital human interest, and here we see the many methods that have been used in past ages and in different climes. Messrs. Bryant and May's collection at their Fairfield Works, Bow, in the main is that formed by Mr. Edward Bidwell during a period of half a century. Perhaps this should have become a national possession, but within the last year it passed into the keeping of the firm, who have housed it admirably. Considerable additions have been made, and it includes every known method of fire making. It is, indeed, so comprehensive that it is difficult to conceive that it can ever be rivalled. The objects are classified under tinder; wood-friction methods; flint-and-pyrites methods; flint-and-steel methods; quartzite-and-iron methods; optical methods; compression methods; chemical methods; and finally the friction match. Of the exhibits, about half represent the flint-and-steel and friction-match methods. The museum is not open to the public indiscriminately, but is accessible to the student, societies, etc., without charge, during week-day afternoons or Saturday mornings, on application to the firm.

A Laboratory Book of Elementary Organic Chemistry. By Prof. A. Lowy and W. E. Baldwin. Pp. ix+182. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 15s. net.

THERE are several novel features about this laboratory manual. Two illustrations form the frontispiece, of which one depicts an alchemist at work, the other a research laboratory at the Mellon Institute, Pittsburg. Instructions to the student are freely illustrated, not only by line-drawings or pictures of apparatus, but also by sketches of industrial plant. The latter are most effective, helping as they do to correlate laboratory experiments with actual practice. The course of work is that adopted at the University of Pittsburg, and an essential part of the scheme consists in writing out a report on each experiment in the form of answers to questions upon perforated sheets, which can be detached when completed and handed to the demonstrator. Afterwards they can be gummed into place again, so that the student may eventually possess a well-illustrated and bound record of his work. Directions are given for the preparation and investigation of a number of fairly simple organic substances, but in the section on carbohydrates, prominence is given to the investigation of cellulose and to the preparation of viscose. Two pages are devoted to the application of dye-stuffs, and a few of the more important reactions of heterocyclic compounds and of alkaloids are appended.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Bands in the Absorption Spectrum of Mercury.

In a paper just published in the Royal Society's *Proceedings* for May, it is shown that excited mercury vapour from a low-current discharge gives, in addition to the better-known feature of the mercury band spectrum, a series of bands which were observed from $\lambda 3055$ to $\lambda 2697$. I find that these bands converge to a point very near the resonance line $\lambda 2537$.

I have now obtained bands of the same system in absorption by a long column of the vapour of boiling mercury, which shows that they involve transitions to or from the unexcited electronic state. These bands are allied to, but not identical with, the emission bands, and converge towards a point in the spectrum somewhat more refrangible than the resonance line $\lambda 2537$. I have obtained about fifty of them. They are seen to best advantage on the border of the region of intense absorption which starts from the resonance line and extends towards the red. As the density of mercury vapour is increased, the region of intense absorption extends farther towards the red, and a part of the band system mentioned is blotted out by the intense general absorption. At the same time the increased quantity of mercury allows them to be traced farther towards the red, and the distinctness is improved. This is very like the behaviour of ozone in the absorption at the limit of the solar spectrum, and also in laboratory experiments, as traced in 1917 by Prof. Fowler and myself.

The mercury bands have not yet been satisfactorily analysed for classification by the quantum theory. There are certain suggestive differences in detail between the emission and the absorption bands. The spacing of these bands is of the order of 10 Ångströms.

In addition to this new system in the absorption spectrum of mercury, it is already known that there are diffuse absorption bands at $\lambda\lambda 2345, 2338, 2334$ and 2339 , thus with a spacing of the order of 5 Ångströms. Closer examination of these has now shown that superposed upon this structure there is a much finer one, of the order of 1 Ångström. This occurs in and between the conspicuous bands named, and extends beyond them as far as $\lambda 2300$ and possibly farther. The spacing becomes closer, and with the instrument at present available I have not been able to resolve the structure any further. In the paper cited I have shown the intimate connexion in *emission* between this part of the band spectrum and the 'forbidden' line $\lambda 2270$. Neither this nor the other forbidden line at $\lambda 2656$ can be detected in absorption.

The mercury absorption spectrum has often been examined before by experienced observers, and it may cause surprise that the features above described have not been noticed. It is due, I think, partly to insufficient length and density of mercury vapour, and partly to the use of an unsuitable bright source for observing the absorption. Bright lines in the source are very baffling.

It is hoped to examine exhaustively these and the remaining portions of the mercury band spectrum with adequate resolving power.

RAYLEIGH.

69 Cadogan Square, S.W.1,
May 16.

No. 3004, Vol. 119]

Modified Scattered X-Radiation due to Super-Position.

MAY I place on record what is, I think, the most direct evidence that the modified scattered radiation is due to the super-position of unmodified scattered radiations? When using a certain primary X-radiation, the scattered radiation from air was found to be totally unmodified radiation, *i.e.* a radiation with accurately the same absorbability as the primary radiation exciting it. The radiation scattered from paper or paraffin-wax was very definitely a modified scattered radiation, or contained a modified radiation, *i.e.* differed considerably in absorbability from the primary radiation. Also these two radiations scattered from paper and from paraffin-wax were equally modified—within a small possible error.

Such results have frequently been obtained in this laboratory. As previously recorded, we have even obtained modified scattered radiation from thick sheets of scattering material, when the radiation from thin sheets was an unmodified radiation as tested by absorption measurements.

In our recent experiments, however, we made a systematic examination of the radiation scattered from various thicknesses of scattering substance. It was found that with a certain primary radiation, when the sheet of paper or paraffin-wax was made gradually thinner, the difference between the primary and scattered radiations became smaller, and ultimately almost vanished, indicating very definitely a vanishing difference for an infinitely thin layer of scattering material.

The possibility of this effect being due in some way to a mere variation of the intensity of ionisation is quite ruled out of consideration by the facts that:

(1) A large variation of output of the Coolidge tube was entirely without influence on the measured difference between primary and secondary radiations, and that

(2) Equal degrees of modification of the rays scattered from paper and from paraffin-wax were produced by scattered radiations of quite different intensity. Thus the slab of paraffin-wax used as scattering substance had to be seven or eight times as massive as the slab of paper in order to produce an equal degree of modification in the scattered radiation as measured by absorbability. Under such corresponding conditions, the intensity of the scattered radiation from paraffin was, roughly, seven times the intensity from the paper.

Plotting the change of absorbability on scattering against mass per unit area of the scattering sheet, we obtained curves of form precisely like the familiar ionisation-pressure curves showing saturation current. In our experiments what was shown was a saturation amount of modification by scattering from thicker layers of scattering material. The maximum amount of modification was shown much earlier for a paper than for a paraffin-wax scatterer, but the two measures of modification were finally equal. Other experiments on this phenomenon—for it of course raises many questions—will be described elsewhere.

It should, however, be added that all X-radiations are not equally sensitive to a change in the amount of scattering substance. The scattering radiation was evidently near the critical condition for a change of its level of activity such as we have described in papers on the *J*-phenomenon. It afterwards settled down to a state in which thick sheets, thin sheets, and even air itself all produced a scattered radiation showing the full amount of modification such as had previously only been given by thick sheets. It is, of course, possible—indeed I think probable—that it was then

necessary only to experiment upon much thinner layers still, in order to obtain the vanishing amount of modification by scattering. This, however, was beyond the range of experiment.

What we have shown is that by experimenting on a suitable radiation, a perfectly regular development of the modified scattered radiation can be traced to the superposition of unmodified radiation from thin layers. This further illustrates what we have previously described as the coherence of superposed X-radiations. Neither quanta nor wave-trains within narrow limits of wave-length can be considered independent in their action; it is the whole stream of radiation which is effective.

C. G. BARKLA.

University of Edinburgh.

Philosophical Foundations of Quantum Theory.

IN his very lucid and interesting article (this is no empty compliment) in *NATURE* of April 16, Dr. Jordan makes two misstatements. On p. 569 he says that in C. T. R. Wilson's experiments the time of a single quantum jump is a measurable quantity. But those experiments involve no time measurements at all. Time enters only through the velocity of the particles; and if inquiry is made how it enters into the value assigned to this velocity, it will be found that the time measurements concerned are made on large aggregates of atoms and have nothing directly to do with quantum jumps. Again, he says that the experiments of Geiger and Bothe and of Compton prove that the interval between emission and absorption is exactly that of the light path between the atoms concerned. But all that these experiments proved was that the interval was less than 10^{-3} sec.; the interval of the light path was about 10^{-9} sec.

Of course Dr. Jordan knew that these statements were not wholly accurate; a limit to accuracy is always set by brevity, and he would doubtless reply that the inaccuracy does not affect his argument. But if there is anything in certain vague ideas which I have twice tried to present to physicists (*NATURE*, 107, 170; 1921; *Phil. Mag.*, 1, 1106; 1926), it does affect his argument very greatly. I must apologise if I am too pertinacious, but every serious writer on the difficulties of quantum theory gives me the same excuse as Dr. Jordan. They all develop their argument up to a point where (as it seems to me) they are bound to notice my suggestion, if only to reject it; they then make some statement about time that is patently false, and, without noticing it, proceed on some different line of thought. If only somebody would explain why the suggestion is too silly to be worth discussing, there would be an end of it, once and for all.

Briefly, the suggestion is that time is a statistical conception, significant only with regard to large aggregates of atoms; and that it is as meaningless to speak of the time interval between atomic events as of the temperature of an isolated molecule. If that suggestion is right, some of Dr. Jordan's questions are answered or become unanswerable. He asks: Will it ever happen that the time of a quantum jump is undetermined? Certainly, for there is no such time.

The conception of a statistical time is, of course, not easy. But the general nature of the influence which it would have on our ideas can be grasped by means of an analogy. If all 'regular' clocks were abolished from our laboratories, and we were forced to use radium clocks, in which the defining events are the disintegration of individual atoms, it would be very difficult to demonstrate some of the experiments on which our conceptions of 'continuous processes' and 'causal relations' are based. That

difficulty, I think, is precisely the difficulty which we encounter when we proceed from the world of atomic aggregates to that of individual atoms.

NORMAN R. CAMPBELL.

I SHOULD like, first of all, to express my regret that up to now Dr. Campbell's most interesting papers have escaped my notice. The expressions which I used, and to which Dr. Campbell takes exception, would certainly have been more precise had I taken account of Dr. Campbell's work.

As for Dr. Campbell's idea, I should like in the first place to point out that the matter has been considerably advanced by two papers by Dr. Dirac (P. A. M. Dirac, *Proc. Roy. Soc.*, London) and by me (P. Jordan, *Z. für Phys.*, 40, 809; 1927) on the foundations of quantum mechanics, and by Dr. Heisenberg's "Über den anschaulichen Inhalt der Quantenmechanik," which is based upon them (W. Heisenberg, *Z. für Phys.*, in press). These investigations corroborate Dr. Campbell's opinion in certain respects; on the other hand, they indicate certain limitations. Heisenberg has explained how the Cartesian co-ordinates, e.g. of an electron in hydrogen atoms, can be regarded as exactly measurable; and correspondingly one must consider the 'fourth co-ordinate', $q_4 = ict$ as exactly definable and measurable. The difficulties of a measurement of t which are brought out by Dr. Campbell arise in the measurement of every physical quantity in an atom (e.g. energy). How and to what extent these difficulties can be overcome has been considered in detail by Heisenberg. In this respect, therefore, the quantum mechanical conceptions differ from those of Dr. Campbell.

In a certain respect Dr. Campbell's views are, however, confirmed by the quantum mechanics: for if the atom has specified quantum numbers, the time (and the co-ordinates) are statistically, and only statistically, defined. For the characteristic feature of the quantum mechanics is that one cannot specify simultaneously all of the $2f$ constants of integration of the classical dynamised system, and, in particular, that one cannot specify both a co-ordinate and its conjugate momentum. Similarly, one may specify the energies of the initial and final states of a quantum jump; then the time of the jump is indeterminate. But one can equally well specify the time of the jump, and leave unspecified the initial and final states; and within certain limits of accuracy one can specify both the initial and final states and the time.

Undoubtedly this discussion is too short and too inaccurate to elucidate the point completely. I should like, therefore, to refer Dr. Campbell again to Heisenberg's paper, in which these questions are treated in detail.

P. JORDAN.

The Law of Flame Speeds.

IN *NATURE* of Dec. 11, 1926, p. 837, Prof. W. A. Bone stated that he would at some future date publish the results of experiments on the 'uniform movement' of flame which disproved the law of speeds. The work referred to has now been published in the *Proceedings of the Royal Society* (A, 114, 420; 1927) and we can reply to Prof. Bone's letter. The principal mixtures he has chosen to test the law of speeds are of ethylene and acetylene with oxygen, and the choice is made because, to use Prof. Bone's own expression, these mixtures are so 'sensitive' (i.e. highly responsive to accidental changes in experimental conditions).

We have for some time been engaged in further study of the law of speeds with the view of ascertaining its meaning. We have not hitherto, in our experiments on the uniform movement, used mixtures of

combustible gases with oxygen, nor have we used acetylene, the very 'sensitiveness' of such mixtures being the reason for our not using them as means of elucidating the law. We have now, however, put in hand experiments with mixtures containing ethylene and acetylene with oxygen, and will publish the results.

Prof. Bone has also used mixtures of methane and hydrogen with air, the inflammable gases being in excess. We have directed attention in our papers in the *Journal of the Chemical Society* to the fact that divergencies from the law of speeds are to be expected, and have been found, with these gases when the oxygen is in deficit. This is admitted on p. 421 of Prof. Bone's paper, but overlooked on p. 438, when the methane-hydrogen experiments are discussed and divergencies from the law are emphasised. Thus it is true that the equimolecular mixture of methane and hydrogen with air in which the speed of uniform movement of flame is 30 cm. per sec. (combustible gases in excess) is not obtained with the calculated (blended) mixtures of methane-air and hydrogen-air having that speed of flame, but with a mixture containing slightly

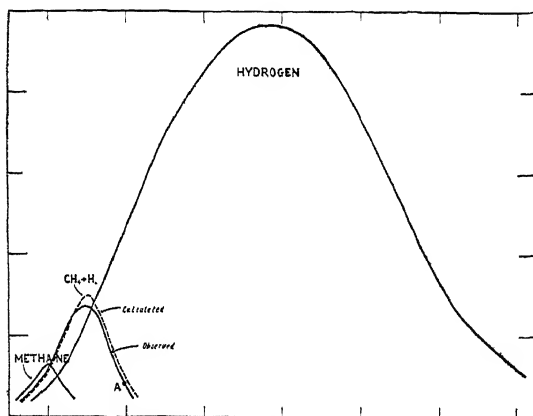


FIG. 1.

more air. Owing to the steepness of the speed-composition curves towards the limits of inflammability, a small difference in the composition scale is magnified considerably on the speed curve. We reproduce, in illustration of this, a set of speed-composition curves embodying the results of series of determinations with mixtures with air of hydrogen, methane, and equimolecular mixtures of these two gases (Fig. 1), from which the full extent and the general nature of the divergencies from the law can be judged. The two mixtures chosen by Prof. Bone to test the law contained 11.05 per cent. methane in air and 71.9 per cent. hydrogen in air. The result obtained with a blend of these two mixtures such as would give an equimolecular mixture of methane and hydrogen would fall near point A on our diagram.

Other examples of the application of the law to the uniform movement of flame, showing the extent of the divergencies, will be found in the *Journal of the Chemical Society* (115, 1454, 1919; 117, 48, 1920). We have recently (*Journal of the Chemical Society*, February 1927) dealt with the application of the law of speeds to a condition of flame propagation other than the 'uniform movement,' namely, propagation within a closed sphere, using mixtures of hydrogen and carbon monoxide with air. The results were in accordance with the law.

W. PAYMAN.
R. V. WHEELER.

Safety in Mines Research Board Laboratories,
Sheffield, April 26.

No. 3004, Vol. 119]

The Spectroheliograph and Direct Telescopic View of Solar Prominences.

It is rather hesitatingly I venture to discuss one or two remarks by Prof. Hale in his interesting contribution entitled "The Fields of Force in the Atmosphere of the Sun," in *NATURE* of May 14, p. 708.

The instances in which I have observed, with perfect ease, intensely black (and bright) hydrogen flocculi, often of stupendous magnitude, suddenly develop near active spots, and even where no conspicuous spots were visible at all at the moment, can be counted by the hundred in my observational notes. I have frequently taken occasion to describe such observations in scientific journals, as well as alluded to them in my annual report to the *Monthly Notices of the Royal Astronomical Society*, which circumstance I wish to mention particularly, because Prof. Hale seems to attribute this kind of observations exclusively to the capabilities of the spectroheliograph, whereas a good solar grating spectroscope has shown me practically all the phenomena he describes, on many occasions. Had I at my station the superior apparatus of Mt. Wilson, or Pasadena, at disposal, and above all the incomparably more numerous and favourable observing opportunities afforded by Californian skies, I should of course be able not only vastly to increase the number of my observations, but also to enjoy better access to the finer detail only seen here when the air conditions are best.

I have also pointed out the drawback of the second slit of the spectroheliograph, which obscures deflexion effects beyond the amount permitted by the width of the second slit, such effects showing perfectly satisfactory with the single slit solar spectroscope. If enhanced seeing is desired, the introduction of a second adjustable, and laterally movable, slit in the focal plane of the ocular of the view-telescope helps to exclude unwanted light from the field of view. Of course, if the second slit is set too narrow, the same difficulty just mentioned in connexion with the second slit of the spectroheliograph is introduced, wherefore in the case of displacement observations, the second slit in the ocular is opened out to the maximum amount of displacement seen through the first slit. Good vision of such evolutions is further enhanced by the use of an eye-cup attached to the ocular of the view telescope.

In spite of the many observations (also shared by myself), which have caused other writers to state that the dark flocculus was sucked through the spot cavity into the interior of the sun, this contention cannot be correct for purely physical and mechanical reasons attending spot evolution. The flocculus may be seen drawn towards the spot vortex, from above and from aside the latter, but on nearing the general upper levels of the spot-umbra, this indrawing action becomes arrested and the gases of the flocculus start to partake of the radial outflow of the gases coming up the spot-cavity from the interior. Where the flocculus encounters these, it becomes heated up temporarily into brightness before being scattered sideways into the penumbral regions.

On May 7, 1927, at 1.45 Greenwich Summer Time, I had the good fortune to witness an exceptionally brilliant eruptive prominence shoot out near Position Angle 85°. The display was for a few minutes of such intensity that the whole length of the spectrum showed indication of being traversed by a ribbon of continuous light. Leaving the slit tangential to the same Position Angle, but using the direct reflecting position of the grating, I had no difficulty in discerning the clear-cut, pale-white form of this prominence. Its brilliance in the first order of the spectrum

induced a reasonable expectation of this direct view, and I feel positive that such a prominence would be readily visible at sunrise, or sunset, with the sun's limb just registering with the horizon.

ALBERT ALFRED BUSS.

Chorlton-cum-Hardy,
Manchester,
May 16.

White Spot with Newton's Moving Water Rings.

LAYERS of moisture, grease, etc., condensed on solid surfaces play an important part in many phenomena, hence it may be of interest to recall an observation made by Newton, which, so far as I know, is never referred to in modern text-books. Observation XI. in "The Second Book of Opticks," Part I. (1704), is one of Newton's many careful observations of the coloured rings seen between convex and plane surfaces of glass, and is as follows: "When the water was between the Glasses, if I pressed the upper Glass variously at its edges to make the Rings move nimbly from one place to another, a little white Spot would immediately follow the centre of them, which upon creeping in of the ambient water into that place would presently vanish. Its appearance was such as inter-jacent Air would have caused, and it exhibited the same Colours. But it was not Air, for where any bubbles of Air were in the water they would not vanish. The reflexion must have rather been caused by a subtler medium, which could recede through the Glasses at the creeping in of the water."

I have taken rough 'snapshots' of this phenomenon, two of which are here reproduced (Fig. 1),

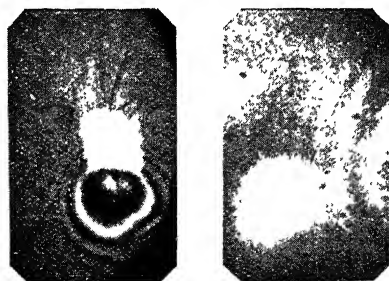


Fig. 1.

but owing to photographic exposure difficulty they do not show the brilliant coloured rings which extend across the white spot. Fig. 1a shows the formation of the white spot sharply at the edge of the dark centre of Newton's rings, indicating that contact (whatever contact may mean) between the glass surfaces extends over the central black spot. Fig. 1b shows the white spot beginning to disappear into the glass or into the water or simply contracting due to increase in pressure. At the rear of the moving Newton's rings pressure will be greatly reduced, so the white spot is probably mainly water vapour at low pressure. That the spot contains gases, however, can be shown by giving the top plate a jerk, when instead of the whole white spot disappearing "at the creeping in of the water," a tiny white bubble of gas may be seen remaining for a long time in the water between the glasses. The white spot can be observed perhaps better because with slower motion, if a viscous liquid such as strong sulphuric acid or vacuum pump oil be used instead of water, or even with a plastic solid like soft soap between the glasses.

JAMES MUIR.

The Royal Technical College,
Glasgow, April 27.

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An Arctic Peat in Ireland.

It has often been stated, and is very generally believed, that no deposits analogous to the Arctic peats of Scotland occur in Ireland. The proximity of the two countries is so great, however, that climatic conditions which affected Scotland must have affected at least the northern portions of Ireland in a similar degree, and it is not surprising, therefore, that an Irish Arctic peat, or something approaching one, has at last been discovered. This peat bed in question is situated on the boundary between the counties Dublin and Wicklow, on the eastern slopes of the Dublin mountains. Locally the place is known as Ballybetagh and Mulligan's Bogs, the former lying in Dublin, the latter in Wicklow. Both bogs have long been famous for the vast quantity of remains of the so-called Irish elk, which has been found beneath them.

The site of the bogs is an oval depression about half a mile long (north to south) by a quarter of a mile in width, and was occupied in late glacial and early post-glacial times by a (?) shallow lake, now entirely filled up by deposits of various kinds. The first post-glacial stratum to be laid down in the lake was a fine bluish-grey clay, sometimes containing chips of stone or gravelly layers, derived by subaerial denudation from the moraines surrounding the site. Resting on this clay, and often bedded into it, lie the scattered bones of the great deer; while in turn these are covered by a flaky peat—locally known as "elk deposit"—which, besides numerous seeds, roots, etc., contains many leaves of *Salix herbacea*. At present my claim that this is an Arctic peat rests solely on the evidence afforded by this willow, though I have just heard from Dr. G. Erdtman, of Stockholm, that a hurried and superficial examination of a sample of the peat from Mulligan's Bog has convinced him that it "is sub-Arctic, if not Arctic."

I have to thank Dr. Henry Stokes, of this city, for permission to examine numerous sections at Mulligan's Bog in August 1926, when he was digging for remains of the Irish elk. I have also to thank Miss M. C. Knowles, of the National Herbarium, for confirming my identification of the leaves of *Salix herbacea*. I may add that the leaves from Mulligan's Bog differ greatly from those of the same willow now growing in the Wicklow Mountains at altitudes of from 2000 ft. to 3000 ft., and resemble the leaves of prostrate specimens of the plant in the National Herbarium from Arctic Europe and Labrador. The present lowest limit of *Salix herbacea* in Wicklow is a little more than 2000 feet altitude, thus suggesting a considerable lowering of the snow-line during the period in which the peat was deposited, Mulligan's Bog being only about 750 feet above present sea-level.

There is at present no proof, but I suggest that the Irish elk may have lived during a comparatively mild period, and that the peat containing the leaves of *Salix herbacea* may be contemporaneous with one of the re-advances of the ice—when the Scottish ice sheet was forming its terminal moraines along the north-east coasts of Ireland, on the Isle of Man, Cumberland, and in south-west Scotland. For evidence connected with these moraines see "The Re-advance, marginal kame-moraine of the South of Scotland, and some later stages of retreat," by Dr. J. K. Charlesworth (*Trans. Roy. Soc. Edin.*, 1926), and also A. R. Dwerryhouse in *Quar. Jour. Geol. Soc.*, 79, 352; 1923.

A. W. STELFOX.

National Museum,
Dublin.

Audibility of Gunfire.

In an article published in *NATURE* last August the suggestion was made that it might be possible to utilise gunfire for accurate measurement of the time of passage of sound over long distances, and in a postscript to the article I was able to record my success in listening at Grantham for the sound of guns discharged at Shoeburyness. On that occasion the interval between the firing of the gun and the arrival of the sound at Grantham varied between $10\frac{1}{2}$ and $11\frac{1}{4}$ minutes.

It is now agreed that 'abnormal' audibility at great distances is due to the refraction of the sound waves in a region at a height of 40 kilometres or more where the temperature of the air is comparatively high. More observations are required to elucidate various problems concerning this region. It is therefore gratifying that the War Office has given approval to the proposal to broadcast the times of firing of one of the guns at Shoeburyness and that the British Broadcasting Corporation is making the necessary arrangements. Full particulars will be announced shortly.

To take full advantage of the opportunity it will be necessary to supplement the aural observations by instrumental records of the aerial disturbance. I am therefore anxious to get into touch with any persons who are provided with apparatus suitable for the purpose. I believe that sets of sound-ranging equipment exist at certain universities and technical colleges. The co-operation of observers who had experience with such apparatus during the War and would be able to utilise it would be especially valuable; it would probably be possible to provide sets for them. It is anticipated that the best distance for successful observations will be at about 120 miles from Shoeburyness, but it will be worth while to attempt observations at rather greater distances, at such places as Nottingham, Birmingham, and Bristol. Records from comparatively near stations, which will be in the region of normal audibility reached by sound waves passing only through the lower atmosphere, are also desirable.

The experimental work on this subject has been done hitherto on the Continent. The trial which we are undertaking offers greater difficulties, as the explosion from which the sound is to originate will be so much smaller. Previous experience shows that as a general rule the zones of audibility are unsymmetrical, so that it is impossible to forecast where the sounds will be perceived. There is, however, reason to believe that in summer the region of abnormal audibility is likely to be to the north and west of the source of sound, so that our trial will be conducted in the most favourable circumstances.

I hope that those who may be able to co-operate in procuring instrumental records will kindly communicate with me at once. Others who are interested and will be able to make aural observations are asked not to write at present. Full details of the trials will be published as soon as possible.

F. J. W. WHIPPLE.

Kew Observatory, Richmond,
Surrey, May 17.

Phytophagic or Biological Races in Insects.

I HAD no desire to enter into any controversial discussion with Dr. Heslop Harrison (whose letter in *NATURE* of April 16, p. 562, I regret not to have seen earlier), either in regard to his experiments or the conclusions he draws from them; I sought only to obtain some explanation of an alleged 'new

principle in evolution,' since anything that deserved such a title would probably be serviceable to me in my studies. I was fully acquainted with the previous paper to which Dr. Harrison refers, as I had particular occasion to consider it at its first appearance. This earlier paper related to the fixing of certain qualities of colour, etc., under chemical influences in food, and I could readily accept it; the second described the fixing of hereditary habits by slight changes of food plants in three generations, and was much less easy of digestion. Yet on the strength of this latter case only (for the former does not touch the real point, and is only connected with the latter by an assumption of a common explanation, a conjectural modification of a wholly supposititious germ-plasm) Dr. Harrison proceeded to specify a number of actual instances of pairs of allied species, particularly stated to be 'in Britain,' and well known to me, and to suggest that this case explained their origin. If he did not mean that they originated in Britain, why describe their British association? It is no evidence that they are similarly associated in Siberia.

I do not deny that food produces differences in species; on the contrary, I know it produces differences. I do not know that it produces specific differences, nor, I think, does any one else. But I cannot believe that in any single instance pairs of allied species come into existence as Dr. Harrison describes; he excludes the essential factor of isolation (either in space or time), without which it would be impossible to keep the two stocks distinct until they were fixed. My case is that many of the most obviously close pairs of species feed not on allied but on the very same species of plants in the same way (I will instance *Tischeria complanella* and *T. dodonæa* on oak, *Heliozela sericiella* and *H. stanneella* on oak, *Antispila pfeifferella* and *A. treitschkiella* on Cornus, all exceedingly close pairs), and that the law of averages renders it unlikely that the direct chemical influence of the food plant is often more effective in other categories than in these, where it is nil.

I should like to add, in relation to Mr. W. H. Thorpe's letter (April 23, p. 602), that the genus *Hyponomeuta*, on which he is working, does, in my opinion, offer the most suitable material known to me for investigations on the direct effect of food plants, and I trust he will obtain valuable results.

EDWARD MEYRICK.

Thornhanger, Marlborough,
May 7.

The Chemistry of the Adrenal Cortex.

IN a previous paper (*Biochem. Z.*, 181, 433; 1927) it was shown that extracts of the adrenal cortex strongly reduce silver nitrate and iodine. This reduction could not be accounted for either by adrenalin or glutathione, and seemed to be specific to the interrenal tissue. To exclude any anticipation of function and chemical structure, the substance giving this reduction was named by its protocoll number "C_{xii}," being the twelfth substance prepared and examined in my work on tissue oxidation and the function of the adrenal cortex. Having been enabled to resume this work at the Biochemical Laboratory, Cambridge, the substance has been further investigated and finally isolated in crystals, which on recrystallisation showed a constant melting-point.

That C_{xii} is definitely confined to the adrenal cortex can be easily demonstrated by the direct application of silver nitrate to the fresh-cut surface of the gland. If a cross-section is made through the (cow's) gland and the pieces immersed into a dilute

(0.2 per cent.) silver nitrate solution, the cut surface of the cortex will be seen to turn almost black within a short time, while the medulla, like other organs, remains practically uncoloured.

The purification of C_{21} was based on the following properties: it is readily extracted by methyl alcohol and precipitated almost quantitatively from its alcoholic (not from watery) solution by lead acetate. It shows a different solubility in organic solvents at acid or alkaline reaction. At an alkaline reaction it is readily soluble in water, methyl alcohol, sparingly in acetone, insoluble in ether and other more hydrophobe solvents, and is precipitated by these latter from its strong alcoholic solution. At acid reaction it is readily soluble in water, alcohol, and acetone, is not precipitated from alcohol by ether, but is carried down by this latter from an acetone solution. The substance does not form a precipitate with any of the great number of other precipitating agents applied. No colour reaction could be found. (The brown coloration on application of acid iodate, mentioned in the first paper, is caused by the liberation of iodine. My first impression that the substance was a thiophenol has been disproved, as no sulphur is found on analysis.) The substance has been crystallised in fine colourless needles from a hydrochloric acid solution, the crystals showing a constant melting-point of 175°C .

The C_{21} content of the adrenal gland (cow) is approximately 0.1 per cent. Preliminary experiments tend to show that the substance is not devoid of biological activity. My earlier experiments, showing that C_{21} is not the hormone of the adrenal cortex, seem in the light of Banting's and Rogoff and Stewart's recent work to be inadequate. Analysis of the biological significance and chemical constitution has been started. A full account of the methods of preparation will be given in another place.

A. v. SZENT-GYÖRGYI.

Biochemical Laboratory,
Cambridge University,
April 30.

Behind the Divining Rod.

RECENT correspondents have not referred to the views that place the use of the divining rod in the category of 'psychological automatisms' like the use of planchette or divination by a ring suspended in a tumbler. A simple experiment will demonstrate such an automatism. An unsuspecting subject is directed to sit leaning forward with his elbows resting upon his knees and with his hands placed just below the level of his eyes. The end of a watch-chain is placed in his hands with the watch dangling between his separated knees, and he is now assured that the watch will swing from knee to knee. Any plausible explanation may be given—bodily magnetism, or the inner movements of the watch—and, unless the subject be critically disposed, the watch as he gazes upon it will swing with increasing amplitude in the direction named. In an experiment with a fresh subject the watch, by suitable assurance, may be made to swing at right angles to its path in the first case.

The movement is produced unwittingly by the muscular action of the subject. The divining rod, as I have seen it used, provides a delicate mechanism by which muscular action can produce movements that the subject apparently, and in his own belief, is trying to resist. I have described the method in "Spiritualism and the New Psychology" (Edward Arnold, 1920).

Testimony as to the honesty of the dowser adds to the pathological interest of the phenomenon; conscious fraud is less pathological than a mild dissociation of personality. Prof. Sollas rightly insists that in tests of ability to 'dowse' coins the investigator

himself should not know what they are, but there is no need to invoke telepathy. There is a super-acuity of the senses, in the presence of a mental dissociation, that enables the 'dissociated' subject to pick up the slightest indications from bystanders or otherwise.

The divining rod has had many uses: to find water, coal, ore, hidden treasure, criminals, and witches. Mechanically and psychologically it belongs to the same category as planchette. Pierre Janet dealt fully with this and other psycho-pathological manifestations in "L'Automatisme psychologique" (Paris: F. Alcan, 1889) and remarked (p. 368): "Il est probable que, dans quelques campagnes, subsiste encore la croyance aux révélations de la baguette divinatoire."

MILLAIS CULPIN.

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Gallium in Flue Dust.

MR. W. KIRBY's observation of the occurrence of the element mercury in coal-tar, recorded by Dr. Aston in NATURE of April 2, p. 489, is another instance of the wide distribution of an element in minute quantity. Employing the method of spectrum analysis by oxy-hydrogen or oxy-coal gas flames (Hartley and Ramage, *Trans. Chem. Soc.*, 71, 533, 1897, etc.) in a search for sources of potassium in flue dusts during the War, certain samples were found to contain notable quantities of gallium. Experiments have been made as occasion permitted to perfect a method for extracting that rare metal from Norwich Gas Works' flue dust, derived from South Yorkshire coal, and in the course of the work the presence of the following elements has been noted: lithium, sodium, potassium, rubidium, caesium, copper, silver, calcium, strontium, zinc, aluminium, gallium, indium, thallium, carbon, titanium, silicon, lead, vanadium, phosphorus, arsenic, antimony, bismuth, oxygen, chromium, molybdenum, sulphur, manganese, chlorine, iron, and nickel. Circumstances have not permitted a complete analysis to be made, and one substance, at least, awaits final purification and identification. Certain selected pieces of dust, partially fritted, apparently contain about 2 per cent. of gallium, and the proportions of zinc and vanadium are probably higher still.

HUGH RAMAGE.

Municipal Technical Institute,
Norwich.

Distinctive Colour Senses of Artists.

THE article in NATURE of May 14 on the exhibition of the Royal Academy reminds me of a discussion I once had with a brother of Sir Charles Walston, who was a medical man interested in art. He was looking out for a method to determine the average colour of a picture, which he thought was characteristic of the painter, and might serve to identify him as certainly as finger-prints identify persons. I could only refer him to the method tried by the third Lord Rayleigh, when instead of spinning colour discs he looked at the stationary discs after reflexion from a surface that could be set into rotation. Applied to a painting, this would then give the average colour for concentric circles round the centre of rotation.

While I am writing, I am looking at portraits of two ladies made by the same artist. The dress of one is bright yellow, that of the other dark blue, and their average colour is not balanced by the colour of the background. The conclusion to be drawn is, that it is dangerous to mix science and art, though we may apply one to the other.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks,
May 18.

The Essential Oils of the Eucalypts.

By Prof. JOHN READ, University of St. Andrews.

THE timbers and the resinous exudations, or 'gums,' of the eucalypts have deservedly attracted much attention; but chemically, if not economically, the greatest interest of this leading genus of Australia centres around the eucalyptus oils. These 'essential' oils are produced abundantly in the minute leaf-glands of the eucalypts, and sometimes they may also be distilled from the bark and timber. Essential oils, as the name indicates, possess fragrant odours; they are more mobile and more volatile than the 'fixed' plant oils, with which they must not be confused; further, unlike the fixed oils, they are unassimilable, being in no way related to the fats.

The early settlers in Australia were quick to notice the value of the eucalypts as sources of essential oils. Dr. John White, surgeon-general to the first settlement, attracted by the strong peppermint odour of a common species growing around Port Jackson, was led to make the first distillation of a eucalyptus oil in 1788. In his "Journal of a Voyage to New South Wales" (1790, p. 227) it is recorded that "the name Peppermint Tree has been given to this plant by Mr. White on account of the very great resemblance between the essential oil drawn from its leaves and that obtained from the Peppermint (*Mentha piperita*) which grows in England. This oil was found by Mr. White to be much more efficacious in removing all cholicky complaints than that of the English Peppermint, which he attributes to its being less pungent and more aromatic." The species of eucalypt which furnished this oil is now known as *Eucalyptus piperita*, and it is common in the Sydney district and the Blue Mountain Ranges of New South Wales. It was sixty-six years later that the first eucalyptus oil factory was established in Australia by Bosisto, while the first chemical investigation was made by the French chemist, Cloëz, in 1870, upon an oil yielded by specimens of *E. globulus* grown in France. Such were the modest beginnings of the utilisation and scientific examination of eucalyptus oils.

Every Australian knows that a eucalyptus leaf, when crushed, often emits an agreeable odour; many know that these odours may vary considerably, from tree to tree, throughout a stretch of bush; and some are able to effect a rough classification of these trees, based upon such observations. Few, however, are able to proceed beyond this point, and it is remarkable that so little exact knowledge should exist, in the popular mind, of a genus which is rightly held in such esteem as an emblem of Australia. In remote parts of Tasmania 'bush-whackers' born and bred among the eucalypts have been known to assert that there are five kinds of 'gums'; but Australian men of science who have devoted their lives to a study of this wonderful genus have distinguished some two hundred and fifty species, and the tale is even yet incomplete. So interwoven are the relationships, so refined the distinctions, that in some instances discrimination between closely related species has been rendered

possible only through the combined efforts of the botanist and the organic chemist. Investigations of this nature, which were prosecuted with unflagging zeal through a period of more than thirty years by R. T. Baker and H. G. Smith, of the Sydney Technological Museum, have demonstrated the remarkable constancy of composition of the leaf-oil derived from any particular species of eucalypt, and have rendered possible a chemico-botanical classification of the various species, through the elucidation of certain remarkable relationships between chemical and botanical characteristics in the genus.

It is usually taken for granted that 'eucalyptus oil' consists mainly, or wholly, of the familiar eucalyptole, or cineole, the smell of which is so familiar during epidemics of colds and influenza. In point of fact, however, cineole is merely one out of about forty chemical components which have been discovered in the oils of this genus since 1870. According to the interesting evolutionary theory of Baker and Smith, the original eucalypts were evolved in north-western Australia from the still older genus *Angophora*, and such species still predominate in this region; the leaves in this group, of which the well-known Bloodwood (*E. corymbosa*) is an example, possess a 'feather' venation and are very poor in oil, of which the main component is the turpentine hydrocarbon, pinene. At the other end of the evolutionary scale, the most recently evolved species occur mainly in the south-eastern portion of the continent; the leaves have a 'butterfly-wing' venation and are thickly studded with oil-glands, so that the yield of oil may exceed four per cent. of the weight of the leaves and twigs. The Broad-leaved Peppermint (*E. dives*), a widely distributed member of this group, furnishes an oil consisting largely of phellandrene, in association with an interesting peppermint ketone, called piperitone, which promises to assume considerable importance as a commercial source of synthetic menthol and thymol. Certain oils in this group are used also in the flotation process for the separation of metallic sulphides from their ores. Cineole is the chief component of the oils from an intermediate group of eucalypts; it occurs as a rule in association with pinene, in such species as *E. globulus*, *E. Smithii*, *E. Australiana*, and many others. Oils of this type are used largely in pharmacy, and they are sometimes so rich in cineole that the crude 'first-hour oil' readily deposits a solid glacial mass of this substance when placed in a freezing chamber.

Chemically, therefore, it is possible to discern three main groups of eucalyptus oils; but in addition there are many exceptional species the leaf-oils of which contain such valuable components as geraniol (*E. Macarthuri*), citronellal (the Citron-scented Gum, *E. citriodora*) and citral (the Lemon-scented Ironbark, *E. Staigeriana*). As a rule, each chemical constituent is found to increase through a range of species until it reaches a maximum value in the final member. In exceptional

cases, such as that of *E. Macarthuri*, the end species alone appears to have survived. In spite of the intricate relationships in the genus, ability to discriminate between the main types is not particularly difficult to acquire. As a practical aid in such studies, an interesting record of the character of the leaf-venation and the disposition of the oil-glands may be obtained by making direct sun-prints of the leaves on sensitised paper. The identification of indigenous species in any particular area is helped by the fact that the chemical fastidiousness of the eucalypt is accompanied by an equally marked susceptibility to environment, so that changes in such factors as geological formation, rainfall, and altitude are reflected in the character of such species.

In harvesting eucalyptus leaves for distillation the trees may either be lopped or felled, and although the latter method may appear extravagant, yet experienced distillers often favour it. The phoenix-like eucalypt conforms to the general motto of the Australian flora, which is 'Resurgam!' It combines amazing vitality with unusual rapidity of growth; and so, after the lapse of a few years, the decapitated stump may have surpassed the ideal of Dean Swift by producing not merely two, but three, or even four, sturdy trunks where only one grew before. To that bizarre list of alleged Australian paradoxes which circulates so freely outside Australia, to the mingled amusement and annoyance of good Australians, may thus be added the less familiar but more truthful statement that a lopped or felled eucalyptus tree, rising on the stepping-stone of its dead self, may in a few years develop more foliage than it originally possessed.

The mallee scrub in the Wyalong district of New South Wales is treated in a still more drastic manner. The mallee, a type of eucalypt embracing many species, is a dwarfed form, having a number of small stems instead of the usual single trunk. In the western part of New South Wales, as also in South Australia and other regions, mallee eucalypts cover vast areas, and the essential oil of the Blue Mallee (*E. polybractea*), the dominant species in the Wyalong district, is worked extensively for cineole. A second species, *E. oleosa*, or Water Mallee, secretes water in its roots, a fact which was fully appreciated by the aboriginal inhabitants of Australia. Other important mallees are *E. odorata* and *E. cneorifolia*, from which the bulk of the South Australian eucalyptus oil is extracted; the last-named species occurs only on Kangaroo Island. In dealing with the Blue Mallee, the oil distiller flattens and partly uproots the mallee scrub by driving a heavy roller over it; and after the hardly used vegetation has dried in the sun he completes its apparent destruction by burning it off. The bare waste which repels the eye at this juncture seems to be devoid of any germ of life. In a short time, however, the irrepressible eucalypt reappears; a pleasing dull blue mantle of *E. polybractea* covers the landscape; and after the interval of a year the oil distiller is gladdened by the sight of a luxuriant growth of mallee rising to the height of his waist.

The harvesting of eucalyptus leaves from the mallee forms is simpler than from the trees, but the subsequent operations are the same for material from either source. In order to liberate the oil, the leaves are brought into contact with steam, which ruptures the oil-glands and causes a slow vaporisation of their contents. The primitive form of bush-still consists of the cubical iron tank so familiar to Australians; this contains the tightly packed leaves resting upon a grating, below which water is boiled by means of a wood fire underneath the tank. As the steam forces its way up through the mass of leaves it becomes charged with the vaporised oil, and the mixed vapours are condensed during their passage through an exit tube cooled by immersion in a creek, or in some more refined manner. The resulting mixture of water and oil runs down the tube and is collected in a receiving vessel, which is so constructed as to allow the relatively small layer of oil to be drawn away from the water upon which it floats. Other types of plant possess an independent boiler which supplies steam under pressure to a series of digesters, these latter being sometimes sunk into the ground to facilitate the handling of the fresh and the spent leaves.

The prices realised by eucalyptus oils range over a wide scale. The value of the oil depends upon its chemical composition, which, although sensibly constant for any particular species, varies enormously from one species to another. The Blue Mallee, for example, yields a cineole oil having a market value of somewhat more than a shilling a pound to the distiller, while the citronellal oil of the Citron-scented Gum of Queensland brought in as much as six shillings per pound during the War. The reputation of the cineole oils has suffered in the past, owing to the multiplicity of species yielding such oils and to the confusion which has existed between these species in the field. A vernacular name, such as Messmate, may easily be interpreted in half a dozen different ways; according to the tastes of the individuals concerned. It is therefore a satisfaction to find reputable oil distillers adopting the systematic Latinised names; and although the use of scientific nomenclature in the Australian bush may occasion some degree of surprise, yet—as a 'bushwhacker' once remarked in different words—there is nothing inherently difficult in the pronunciation of 'Eucalyptus Macarthuri,' and the name is decidedly more euphonious than the synonymic Camden Woolly Butt or Paddy's River Box. Fortunately, neither *E. Luehmanniana* nor *E. macrorhynca* is worked for oil!

As his readiness to use these strange names shows, the oil distiller is eminently adaptable; he has been known to write his letters with home-made charcoal ink by the light of a lamp burning the oil of *E. Macarthuri*. He is, indeed, a virile and picturesque Australian type, full of the lore of the bush. Let us hope that some day an Australian master will arise to do by him as Thomas Hardy has done by the tranter and the reddleman of Wessex.

Evolutionary Advance: Emergent and Resultant.¹

By Prof. C. LLOYD MORGAN, F.R.S.

THERE seems to be not a little misapprehension as to the position which those who advocate emergent evolution are concerned to defend. Some critics seem to suppose that the contention is: All evolution is by discrete steps, each of which introduces something new; therefore no evolution is by continuous advance with resultant outcome. That is not so. At any rate, I, for one, disclaim intention of saying anything of the sort. It has been my aim to emphasise the claim that what is genuinely new in evolutionary advance is of the emergent type, as distinguished from the resultant type. My claim is: Some evolution is by discrete steps, each of which introduces something new. But stress on emergent factors in evolution does not imply denial of resultant effects.

When we consider organic evolution this must be borne in mind. If the biologist adduces thousands of examples of changes in living organisms which are interpretable mechanically as strictly resultant, that is no argument which serves to disprove the occurrence of changes which, as we think, must be interpreted as strictly emergent. If both types of change are in evidence, our aim should be to distinguish the one type from the other.

The emergent claim is (1) that there are certain characterising features of the living that cannot be deduced from our knowledge of what happens on the lower platform of the not-living. But the further contention is that this holds good, not only for the living and the not-living, but also at many stadia of evolutionary advance; so that, on like empirical grounds, we may say, for example (2), that there are certain characterising features of the molecule that cannot be deduced from our knowledge of what happens on the lower platform of the atom.

It is with the former claim that we are here concerned. Then the trouble is that one who advocates emergent evolution is sometimes supposed to deny resultant evolution. He is supposed to say in effect: *Not resultant advance, but emergent advance.*

Let us consider the attitude of those who do nothing of the sort. In resultant advance the conditions are such that there is homogeneous continuity. Hence deductive conclusions are relevant all along the line of advance. With adequate knowledge of the law of such advance, predictions as to the exact nature of any later phase could be made on the basis of adequate and sufficient knowledge of any earlier phase. Hence the unlimited range of astronomical predictions in so far as they are based on the principles of resultant mechanics.

Now what is the bearing of this on the vexed biological issue? The 'mechanist' says in effect that all processes and products from first to last—from the not-living to the living organism—are

susceptible of resultant interpretation. They are all on one continuous plane of resultant advance. And he points with justifiable pride, which others may share, to the outcome of such treatment. There are, no doubt, as he frankly admits, sundry physiological processes which still present difficulties. What of that? Further research on this method of interpretation will resolve them in due time.

What, then, say those who have been led to accept emergent advance? Do they deny any one of the successful achievements based on resultant treatment? They do not. What they do submit is that there are modes of 'behaviour' in the clustering of events within the living organism that are of such a nature as not to be deducible from that which obtains in the not-living. They submit, in further detail, that there are *some* physiological processes which elude the meshes of the resultant net, which are on a different level of emergence, which could not be predicted from the not-living platform.

It may be asserted that with further knowledge it will be shown that there are *no* physiological processes that elude the resultant net. We are, however, dealing with matters as they now are; and our attitude is: Resultant advance in plenty; as much as can be proved; but not a few residual matters which bear witness to emergent advance. If this be so, is not the present position of affairs this: The living organism in physiological regard is such as to exemplify evolutionary advance, not resultant only, not emergent only, but both resultant and emergent?

Should not this be our attitude in broader biological regard? Now that the concept of emergence has been admitted into the field of serious discussion, there is grave danger of its being used wildly and without discrimination as a popular catchword. People talk of the emergence of the elephant or the mongoose; the emergence of the social Hymenoptera, of polymorphism in ants; perhaps the emergence of mimicry or of display in courtship.

It may, however, be said: We thought that evolutionary advance is what you stand for. But now it seems that you propose to introduce sundry rather puzzling reservations. If polymorphism in ants—to select one of your examples—if, in other words, the differences of structure and diversities of behaviour that characterise the constituent members within some social community of ants, be not the outcome of evolutionary process, of what natural process is all this the outcome?

I do not suggest that all this is not the outcome of, or does not afford an instance of, *evolutionary* advance. My aim is to distinguish, within this advance, (1) that which is deducible on the method of resultant treatment, from (2) that which is not deducible on this method. The former I speak of as resultant advance; the latter as emergent advance. I submit that, on the evidence, we find

¹ From a paper read at a meeting of the Aristotelian Society on Feb. 14.

in the field of biological inquiry both emergent and resultant advance. My plea is for careful analysis.

There are a good many critics who seem not yet to have grasped just where the concept of emergent evolution is applicable. They seek to apply it where I, for one, hold it to be inapplicable. They may then ask: What bearing has this concept of emergence on the theory of natural selection? It may savour of extravagance if I express the opinion that on this theory, as such, it has little or no bearing.

To make my meaning clear, I must ask: Are we, under natural selection, dealing with the survival of variants or with the origin and transmission of variations? In the opinion I express I assume that the theory of natural selection *as such* deals with variants, and that the origin and transmission of variations fall for discussion under a different theory—that of genetics. If this be so, the issue for natural selection is a plain issue. Are some variants weeded out in 'the struggle for existence' or are they not? If some are weeded out, leaving others

to survive, I regard such elimination as a resultant effect.

That leaves the origin of variations (or of mutations) to be discussed as a separate issue under genetics. It opens up a wide field of inquiry, including Mendelian research. Here the question does arise: Is this or that variant the outcome of resultant, or emergent, advance; or is it a joint product of both? If both are given in the evidence, the emergent factors should be distinguished.

My plea is: If the concept of emergence be accepted, let us make quite clear just where this concept is applicable. When I express the opinion that it is not applicable to natural selection, as such, it should be obvious that this does not preclude the survival of those variants which have genetic characters that can be shown, under searching analysis, to be emergent in origin. Biological inquiry includes both natural selection and genetics; and genetics discloses, as I think, both emergents and resultants. Is there not pressing need for the exercise of distinguishing analysis?

Fat-soluble Vitamins.

BARELY two decades have elapsed since the concept of 'vitamins' first began seriously to attract the attention of investigators. Scurvy had been recognised as a clinical entity for a couple of centuries, and the treatment of it, by means of fresh vegetables and fruit juices, was well known. But the idea that disease might be caused by the *deficiency* of some factor in the diet was, for many, too novel to be accepted without question, and much work was necessary before the reality of the accessory food factors or vitamins was generally admitted. Recognised at first solely by the effects produced on experimental animals when absent from their carefully purified diets, it was not long before chemical investigations began to define their properties, from which tentative conclusions as to their chemical nature might be drawn. With the discovery that ultra-violet light could cure rickets, and was also capable of making a diet, previously inactive, protective against this disease, a new key was provided for the unlocking of the door which led to the chemical constitution of the anti-rachitic vitamin, or vitamin D, as it is also called. At this stage the work came into contact with other investigations on a group of compounds of widespread distribution in Nature, but of almost unknown biological significance, the sterols. At the present time it is certain that vitamin D, if not actually a member of this group, is closely related to one, and it is extremely probable that vitamin A, or the fat-soluble growth-promoting vitamin, is also of a similar nature.

Following the discovery that exposure to ultra-violet light could render a deficient diet anti-rachitic, it was soon found that the unsaponifiable fraction of the fat of the diet was responsible for this effect. O. Rosenheim and T. A. Webster, working at the National Institute for Medical Research, and Steenbock and Hess and their

collaborators in America, then discovered independently that 'chemically pure' cholesterol was rendered anti-rachitic by this exposure. Further work by these and other investigators has now sufficed to determine more definitely the properties and nature of the compound which undergoes this change, although the actual nature of the change itself is undetermined.

Rosenheim and Webster (*Biochem. Jour.*, 1926, vol. 20, p. 537; *Lancet*, 1927, vol. 1, p. 306) were unable to convert more than 0.1 per cent. of cholesterol into vitamin D under the influence of ultra-violet light. They also showed that the presence of the unsaturated linkage and of the secondary alcohol group of the sterol was essential for the reaction to take place, and that the vitamin was not precipitable by digitonin. The fact that only a minute amount of the cholesterol could be 'activated' raised a doubt as to whether this substance was the true precursor of vitamin D, and the doubt became a certainty when it was found that cholesterol purified by way of the dibromide could not be activated and, moreover, no longer possessed the characteristic absorption spectrum in the ultra-violet region. These experiments proved that the vitamin precursor is not cholesterol itself, but some substance which is closely associated with it when obtained from all natural sources.

Further work showed that the precursor was easily oxidised and could also be precipitated by digitonin, unlike the vitamin obtained from it. Attempts to separate it from cholesterol by making use of the latter property, or by fractional crystallisation (Heilbron, Kamm, and Morton, *Jour. Soc. Chem. Ind.*, 1926, vol. 45, p. 932) or by fractional distillation in a high vacuum (Windaus), resulted in a considerable concentration of the precursor, but it was not obtained in a pure state.

The authors therefore selected another sterol, ergosterol, which they had previously shown could be rendered anti-rachitic by ultra-violet light, for further examination, since it possesses some of the properties of the vitamin precursor: thus, it cannot be recovered unchanged from its bromide (Windaus), it is extremely sensitive to light and oxidation, forms an insoluble digitonide, and possesses three unsaturated linkages. It was found that this sterol exhibited a very pronounced absorption in the ultra-violet region of the spectrum, which disappeared on irradiation; at the same time the product lost the property of being precipitated by digitonin. Experiments on rats suggested that the limit of anti-rachitic activity will be in the region of a daily dose of $\frac{1}{1000}$ mgm. or less.

It is therefore probable that the vitamin precursor is really ergosterol: similar or identical sterols have been found widely distributed throughout the lower plants. Thence they must find their way into animals, thus enabling the latter to develop their own anti-rachitic vitamin on exposure to light. The anti-rachitic power developed by cholesterol on irradiation, then, is due to contamination of this compound with ergosterol; from the intensity of the ultra-violet absorption spectrum it appears that this contamination occurs to the extent of about 0.05 per cent.: this assumption also explains the impossibility of making anti-rachitic more than a small amount of the "cholesterol."

Less is known at the moment about the nature of the fat-soluble vitamin A. Like vitamin D, which has only recently been definitely differentiated from it, it occurs in the unsaponifiable fraction of the fats and oils (notably codliver oil) in which it is present. Following the work of Drummond, Takahashi, and other investigators, certain of its properties have become established (see NATURE, 1926, vol. 117, p. 522, and J. C. Drummond, H. J. Channon, and K. H. Coward, *Biochem. Jour.*, 1925, vol. 119, p. 1047). Thus the vitamin A present in the cholesterol-free oil obtained from the unsaponifiable matter of codliver oil can be distilled at low pressure at a temperature of about 180°-220° C.: only small amounts are obtained, the greater part of the purified oil consisting of unsaturated alcohols together with a certain amount of squalene. Even the product obtained in this manner is impure, so that Drummond was unable to agree with Takahashi with reference to the claim advanced by the latter that he had isolated the vitamin in a pure state. Drummond noticed that the growth-promoting activity was retained after destruction of the hydroxyl group of the alcohols present, but was always destroyed by exposure to reagents which affected the unsaturated linkages. More recently Rosenheim (*Med. Res. Council Rep.*, 1925-6, p. 30) has found that partial oxidation of cholesterol produces a substance which gives the colour reaction characteristic of vitamin A (and a few other substances). It is therefore possible that vitamin A may also be found to be a derivative of one of the sterols.

The story of the work on the fat-soluble vitamins A and D shows how two entirely different lines of research may suddenly converge, and how a purely academic investigation may suddenly assume a definite practical importance. Without the knowledge obtained from the work of previous investigators on the sterols, the biological importance of which was not at the time obvious, it is possible that the isolation of these two vitamins would have taken much longer than it now seems probable will be the case.

The practical application of these researches in the prevention and cure of rickets is obvious: but this is not a very common disease, so that it is worth inquiring if deficiency of these vitamins may play a part in other diseases or states of ill-health. Drawing an analogy from the symptoms shown by rats suffering from deficiency of vitamin A, it is probable that this vitamin plays a part in maintaining the various mucous membranes of the body in a healthy state, quite apart from any effect it has on proper growth: in fact, deficiency of this vitamin has led to the appearance of xerophthalmia in human beings just as in experimental animals.

At the same time, increasing light is being thrown on the relationship between vitamin D and the formation and decay of the teeth, a subject of very great importance. Mrs. Mellanby first demonstrated this relationship in the case of animals, but the application to human beings was not immediately obvious, since dental decay occurs frequently in apparently perfectly formed teeth. Mrs. Mellanby has, however, found (*Med. Res. Council Rep.*, 1925-6, pp. 18 and 74) that teeth, normal to naked-eye examination, may show defects of structure of both the enamel and dentine when examined microscopically. Decay was almost general in these teeth, whilst only one-quarter of the well-formed teeth were affected.

With C. L. Pattison, Mrs. Mellanby has investigated the extension of caries in children on different diets, and has found that increasing the vitamin D and decreasing the oatmeal has reduced the extension, when compared with less satisfactorily constructed diets.

The fact that apparently well-nourished people give signs, in the structure of their teeth, of a specific vitamin deficiency in their diet, is of great interest. It suggests that the supply of vitamin has been inadequate, and that in the competition for the amount provided in the diet, the teeth fail to obtain their due share. This work brings the problem of dental decay within the sphere of nutrition, and points the way to effective prevention: either the diet must be improved by the increased use of natural foodstuffs containing the vitamin, or a palatable and cheap source of the vitamin must be available. The work on the irradiation of ergosterol gives grounds for suggesting that it may be possible to provide, in the near future, vitamin D in a highly concentrated form, to be used either by itself as a medicament or for the enrichment of suitable articles of diet.

Obituary.

DR. W. COLLINGRIDGE.

DR. WILLIAM COLLINGRIDGE, who died on April 29 at seventy-three years of age, went up to Cambridge as a young man, and while there his medical studies were interrupted by the circumstance that he volunteered surgical services to the Serbian Forces during the Turko-Serbian War. On his return to England he resumed his studies at the University and graduated in medicine. After two years of private practice he was appointed (1880) Medical Officer of Health of the Port of London, and during his twenty years' tenure of this post he contributed materially to the advances made in port sanitary work. The period was an eventful one; for two continental epidemics of cholera seriously threatened Great Britain, and the measures he devised and conducted were of great assistance in securing the immunity from infection which London, and the country generally, enjoyed. In no small measure are we indebted to Collingridge for the comparative composure with which we should face such risks at the present day.

Collingridge's special knowledge and experience led him to become a great opponent of the old practice of 'quarantine'; and this was the subject which he discussed, most ably, in his Milroy Lectures to the Royal College of Physicians (1897). He maintained that no attempt should be made to enforce quarantine in a commercial country, now that other more satisfactory measures of safety were available; and he gave opinions supported by facts that such measures had certainly been evolved. Quarantine was expensive; it often failed, and thus gave a false sense of security; and it involved serious danger to those detained on the ships. Sanitation, the medical inspection of passengers and crew at some suitable mooring station, the hospital isolation of infected persons and the temporary detention of suspects, constituted a scheme which presented many advantages. These views have now met with a very wide acceptance. It was also during these years that he became a warm advocate of improved sanitary conditions in the mercantile marine; and he was a pioneer in securing such improvements, although the existing conditions still leave much to be desired.

In 1901, Collingridge was appointed Medical Officer of Health for the City of London—a post which he retained until 1913. It was inevitable that in this sphere of work also he would leave a deep impress of progress in measures to promote the public health. He recognised the danger from oysters bred in waters polluted with human sewage, and his persistent advocacy of the adoption of protective measures led to useful progress towards safety. He extended these operations to what he styled "the poor man's oyster"—the cockle—to the consumption of which he attributed, with good cause, much preventable illness. He always impressed the public health need for cleaner milk and did much to secure this in the City of London.

After his retirement from public health official work, Collingridge still remained deeply interested

in public health matters. Throughout the War he was in charge of Auxiliary Military Hospital No. 112 in Kent. He maintained to the end his connexion with the Royal Sanitary Institute, of which he had been a member of Council and with which he was connected for nearly fifty years.

PROF. D. A. GILCHRIST.

By the sudden death of Prof. Douglas Alston Gilchrist, professor of agriculture, University of Durham, Armstrong College, Newcastle-on-Tyne, on April 4, agricultural education and the agricultural industry of Great Britain have suffered a great loss. Prof. Gilchrist was the son of a west of Scotland farmer, and after leaving school, spent twelve years in practical farming, in which period he secured a thorough knowledge of the practical work and problems of farming. Afterwards he commenced to attend agricultural and science classes at the Glasgow and West of Scotland Technical College, and later made his way to Edinburgh, where he graduated B.Sc. (in agriculture) in 1889. In addition he obtained the senior certificate of the Royal Agricultural Society of England, and the diploma in agriculture of the Highland Agricultural Society of Scotland. In 1903 he was granted, by vote of Convocation, the degree of master of science in the University of Durham.

Bangor (North Wales), Reading (south of England), and Newcastle-on-Tyne were the three centres of Prof. Gilchrist's life work. He also visited France, Holland, Italy, Germany, and Canada, with the object of knowing something of agricultural education, research, and the practice of agriculture in these countries. In 1902 he was appointed to the chair of agriculture at Armstrong College and scientific director of the Northumberland County Experimental Station at Cockle Park. The abundant labours of the past twenty-five years are known and appreciated by a vast number of agriculturists, not only in Great Britain, but also all over the world. He was best known for his research in connexion with grass and clover seeds mixtures, and the improvement of permanent grassland by means of economic dressings of phosphatic manures.

When Prof. Gilchrist came to Newcastle there were six academic members on the staff of the Agricultural Department of Armstrong College. There are now sixteen such members, six of whom are advisers, the College being the northern provincial centre of higher agricultural education of the Ministry of Agriculture. By his writings and lectures delivered in various parts of the country Prof. Gilchrist was well known all over England. The experiments and demonstrations he organised at Cockle Park have had a marked effect upon farming in the north of England as well as in other parts of the country. He was much beloved by his colleagues on the staff of the Agricultural Department and his many students.

News and Views.

At the recent monthly meeting of the Zoological Society, the Duke of Bedford presented the bronze medal of the Society to Keeper E. Bowman for the successful rearing of the young male hippopotamus which was born in the Society's Gardens at Regent's Park last August. A similar award has not been made since the year 1872, when the last baby hippopotamus was reared by Michael Prescott and Arthur Thomson. This animal was "Guy Fawkes," who afterwards lived for thirty-six years at the Zoo. In nine months the present youngster has trebled his birth-weight, which was in the region of a hundred-weight, and now seems to be well on the way towards equalling the record set up by his famous predecessor. Some interesting facts were recorded at his birth and during the time which followed. From the Keeper's own observations in this case and previous records made by A. D. Bartlett in 1871 and 1872, the period of gestation for the hippopotamus has been fixed at 240 days. The mother's behaviour immediately before parturition indicated that in Nature birth probably takes place in very shallow water or in a bed of reeds at the water's edge. Although unable to stand or walk properly, the young one shuffled along on his knees into the water a few hours after birth and swam round the pond with his mother. After a time the mother submerged her body entirely and turned on her side. The young one immediately began to suckle under water, coming up to breathe at intervals varying from twenty to forty seconds. This he has continued to do up to the present time, although he has now cut a good set of milk teeth and is able to eat a certain amount of solid food. He has occasionally been observed to remain under water for so long as three minutes while suckling. The average time for an adult hippopotamus to stay submerged is four minutes.

DR. A. C. D. CROMMELIN, who retired from the Royal Observatory, Greenwich, on May 11, after thirty-six years' service, was educated at Marlborough and Trinity College, Cambridge. After a short time as assistant master at Lancing, he obtained by competitive examination a post as junior assistant at Greenwich in 1891. Dr. Crommelin was a regular observer with the transit circle, altazimuth, and Sheepshanks' equatorial. He had a wide general knowledge of astronomy and became an authority on questions connected with comets, minor planets, dates and times of eclipses, etc. His frequent notes on comets and his annual reviews on minor planets, as well as the physical ephemerides which he calculated for objects in both these groups, have been of great service. It was Dr. Crommelin who suggested to Dr. Cowell that they should calculate the 1910 return of Halley's Comet, and by the elegant method devised by Cowell, they predicted the return correctly to two days. For this they received a prize offered by the Astronomische Gesellschaft and the degree of D.Sc. from the University of Oxford. Dr. Crom-

melin went to the eclipses of 1896, 1900, and 1905, and had the good fortune to take part in the observations in 1919 which verified the bending of light predicted by Einstein. He has served on the Council of the Royal Astronomical Society since 1906 and was secretary from 1917 until 1923. He has also been on the council of the British Astronomical Association since 1896 and was president 1904-1906. Dr. Crommelin is such an enthusiastic astronomer that his work will not cease with his retirement from Greenwich. He has for several years been the chief contributor of notes in our Astronomical Column, and we hope to continue to have the advantage of his valuable co-operation.

ACCORDING to an announcement circulated by Science Service, of Washington, Dr. H. Fairfield Osborn has reported to the American Philosophical Society the discovery of fossil bone implements in Nebraska of Pliocene age. More than three hundred implements of forty different types have been found. They are made of the fossilised bones of extinct animals—camels, horses, deer, elephants, and mastodon. The exact locality of the discovery is not disclosed, beyond that it is in western Nebraska, in order to protect the site. The first find was made two years ago, and since then machinery has been used in excavating the area. Two localities about 75 yards apart have produced most of the finds. Dr. Osborn regards the implements as of undoubted human origin. Among them are skin dressers, awl-like implements, neck ornaments of strung bones, and a comb-like form that may be a tattooing implement. Eighteen of the types have been matched with counterparts from the ruins of cliff-dwellers of the south-west, and one can be nearly duplicated by a much more recent implement from a shell-mound in eastern America. Pending further information as to the geological evidence upon which the date of these implements has been determined, judgment must remain in suspense, although the opinion of Dr. Osborn must be given full weight. The comparison with the implements from the cliff dwellings is not necessarily reassuring until we know the types which present these similarities and have indubitable evidence of their high antiquity. Should this be established, the discovery will give strong support to those who have favoured the human character of the tooth discovered in the Pliocene of Nebraska a few years ago.

FARADAY'S lecture theatre at the Royal Institution was on May 18 the scene of a meeting of the Chemical Society and its distinguished guests, amongst whom was Lord Balfour, to hear the Faraday Lecture delivered by Prof. Richard Willstätter, whose discourse was devoted to a consideration of problems and methods in enzyme research. Taking Faraday's experiments "on the power of metals and other solids to induce combination of gaseous bodies" as the

starting-point in his discussion of organic catalysts, Prof. Willstätter said that the catalyst may function in degrees of association with the substrate varying from fixation to approach, the continuous distribution of electrical charges of the catalyst and the substrate mutually influencing one another. Platinum is capable of transferring hydrogen catalytically only in the presence of oxygen, hence the oxygenated platinum may be regarded as comparable with the enzyme-activator complexes. No single hypothesis is adequate to explain all the phenomena, but in enzyme chemistry no theory is so fruitful or so satisfactory as that assuming the existence of intermediate compounds between catalyst and substrate. The enhanced effects produced by mixed inorganic catalysts are closely analogous to the differences in potency and specificity exhibited by such enzyme systems as trypsin and trypsin-kinase or papain and papain-hydrogen cyanide. These catalytically active mixtures may be of the nature of new chemical compounds; the assumption that the admixture to the simple catalysts merely increases the frequency with which the catalytically active atoms stick out from the lattice is inadequate.

PROF. WILLSTÄTTER dealt also with the problem of the isolation of the enzymes in a state of purity, a problem which is in process of solution by taking advantage of absorption effects of alumina, kaolin, lead phosphate, etc., followed by elution with very gentle chemical reagents. No less should the method of preparation of an inorganic catalyst aim at increasing as much as possible the efficiency of unit weight of the material. Prof. Willstätter gave examples of the use of the process of purification by adsorption in determining whether or not certain elements such as iron or phosphorus are essential constituents of the enzymes. There is, however, no certain method of freeing the enzymes from protein derivatives. The tenacity with which proteins cling to enzymes threatens again and again to impose the conclusion that the enzymes are of a protein character. Invertase can, however, be freed almost completely from various chemically recognisable substances of high molecular weight without loss of activity or stability. The highest degrees of enzymic purity hitherto obtained have been achieved by a process of fractional adsorption on a finely divided precipitate, whereby an enzyme can be separated even from the products of its inactivation. In many cases there are indications as to which atomic groups of an enzyme are responsible for its union to an adsorbent, and delicate gradations in adsorptive power are determined by differences in the constitution of the particular gel employed. The only property of enzymes which is independent of their varying degree of purity is, apparently, their qualitative specificity. It is even possible, in certain cases, to ascertain the particular atomic group of the substrate molecule towards which the enzymic activity is directed.

In addition to the official welcome given to Prof. Willstätter by the Chemical Society, a number of

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members of the Athenæum, representing many branches of biological and chemical science, entertained him at dinner at that Club on May 17. Prof. H. E. Armstrong was in the chair, and by the kindness of the director of the Royal Botanic Gardens, Kew, the table was decorated with some of the flowers of which the pigments have been investigated by the guest of the evening. When, in 1913, Willstätter and Everest described their work on the pigment of the blue cornflower, which they called cyanin, they laid the foundation of the fuller investigation of the anthocyan pigments that has been developed so successfully since that date, with the result that the colouring matters of the rose, pelargonium, viola, peony, hollyhock, cherry, and many other flowers are now known. Prof. Armstrong made a felicitous reference to an extract from Walt Whitman's "Leaves of Grass" in proposing the toast of Prof. Willstätter at the dinner:

"A Child said, 'What is Grass?' fetching it to me with full hands.

How could I answer the child?

I do not know what it is any more than he.

I guess it must be the flag of my disposition, out of hopeful green stuff woven."

Prof. Willstätter was welcomed as the man who had so greatly helped to draft what must finally be the answer to the child's question, at least in respect to the mingled greens and yellows which make up the beauty of plant colours; and Prof. Armstrong expressed the hope that he would return to this field of inquiry and discover new secrets in it.

In a report from Cairo, Dr. Reisner states that at the moment of closing down operations for the season, the Harvard-Boston Expedition has made another discovery of no little importance at Giza. While excavating the burial chamber of Queen Hetepheres discovered two years ago, the clearing of the Royal Necropolis eastward of the Great Pyramid has proceeded simultaneously, and here, on what was intended to be the last day of the season's work, a doorway in the rock was disclosed which proved to be the entrance to the tomb of Meresankh, a granddaughter of Khufu (Cheops) and great-granddaughter of Queen Hetepheres, wife of Seneferu. It appears that three halls of the funerary chapel have been discovered. Statues and statuettes stand in niches in the walls; but the special feature of the tomb is the decorations in relief and colour. Some of these were added after the original decoration, one being of a son of Neweserraankh, a king of the Fifth Dynasty who claimed royal descent from Queen Meresankh, possibly being her grandson. This gives six generations descended from Queen Hetepheres represented here, extending from the Third to the Fifth Dynasty. According to the account given in the *Times* of May 19, all the figures show the characteristic physique of the family of Cheops, a receding chin, stumpy build, and obesity. One outstanding feature of the report is that a representation in relief of Hetepheres, daughter of Khufu and mother of

Meresankh, has short yellow or red hair. This is the earliest representation of that variant of pigmentation among the dark-haired Egyptians, and opens up an interesting field of speculation as to racial admixture at this early date.

A MEMORANDUM on the inscription of Darius I. recently discovered at Hamadan has been submitted by Prof. E. Herzfeld to the Indian Archæological Department. The record, which was engraved in three languages, old Persian, Elamite, and Babylonian, on each of two tablets of gold and silver, fixes the limits of Darius's empire "from the Saka, who are beyond the Sugd as far as the Kush, from the Hindu as far as Sparda." According to an account in the *Times* of May 19, Prof. Herzfeld concludes that Darius added Hindu to his conquests in 516 B.C. More important than his determination of the date, however, is his identification of Hindu with the third Indian sculptured figure of Darius's tomb, the other two being Gandara and Thatagush. The location of the last named had not hitherto been determined, but it is now suggested that the specific mention of Hindu, that is. Sind (Persian H=Indian S), and Gandara occupying the Kabul River Valley, Swat and the country around Tazila, fixes Thatagush (Persian Satagus, Indian Satagav—"having a hundred head of cattle") as having inhabited the Punjab. The inscription has a further significance in its bearing upon early racial distributions, for in giving the location of Saka as beyond the Sugd, Prof. Herzfeld holds that it throws light on the home of the kindred tribes which occupied the country between the Danube and central India and founded the empire which extended from Seistan to Malwa in central India.

At an extraordinary meeting of the Council of the National Union of Scientific Workers, held at Caxton Hall, Westminster, on May 21, it was decided to change the name of the society to "The Association of Scientific Workers" in accordance with the votes cast by members and potential members for each of three titles, "The Association of Scientific Workers," "The Association of Scientists," "The Institute of Scientists." It was also decided, in order to give every qualified scientific worker in Great Britain the opportunity of becoming a member of the society, to make the subscription rate, as from Jan. 1, 1928, a minimum of ten shillings, leaving it to members to increase this amount according to their means. In view of the attitude of the Government towards professional organisations, as outlined by Mr. Ronald McNeill, the following resolution was put and passed unanimously: "That this Council Meeting of the Association of Scientific Workers calls on H.M. Government to amend Clause 5 of the Trade Disputes and Trade Union Bill in order to make it clear that civil servants in professional and technical grades are not deprived of the right to organise in their respective professional organisations, which have for their principal objects the maintenance of a high standard of professional attainment and the general

improvement of status and conditions of service among their members, by whatever authority employed, as well as the spread of scientific knowledge and the increase of public support for scientific work. It reminds H.M. Government that H.M. Government has adopted the policy laid down in the Report of the Committee on State Servants that the professional man in the Civil Service, unlike any member of the administrative or fighting services, should relate his pay and position with those of his professional brethren in the outside world, which implies that the professional civil servant should be organised with his brethren in outside occupations."

DURING the past few days, long-distance flights by aeroplane have been well to the fore. Nungesser and Gali set out on May 8 from Le Bourget, near Paris, to cross the Atlantic, but at the time of writing, no news has been received of them. On May 20, two long-distance journeys commenced. Capt. Charles Lindbergh took off from Roosevelt Field, Long Island, New York, at 7.50 A.M. with the intention of making a non-stop flight to Paris; and Flight-Lieutenants C. R. Carr and L. E. M. Gillmans started at 10.42 A.M. from Cranwell Aerodrome, Lincolnshire, on a non-stop flight to India. Capt. Lindbergh landed at Le Bourget at 10.30 P.M. on May 22, having flown some 3500 miles in 33½ hours. His machine was a Ryan monoplane fitted with a 220 h.p. Wright "Whirlwind" engine and he carried 448 gallons of petrol. His course was along the American and Canadian coast to Newfoundland, across the Atlantic by a northerly route, along the south coast of Ireland, to Cornwall, Cherbourg, and Paris. Capt. Lindbergh was alone, and his feat was a noteworthy achievement of skill and endurance. Only once before has the Atlantic been crossed in one stage of flying and that was in 1919, when Alcock and Brown, flying a Vickers-Vimy machine, left the coast of Newfoundland at 4.28 G.M.T. on June 14 and landed at Clifden, Ireland, at 8.40 G.M.T. on June 15, having flown nearly 1900 miles. Lieuts. Carr and Gillman, on their attempt to reach India, flew a Hawker Horsley day bomber fitted with a 650-700 h.p. Rolls-Royce "Condor" engine, and carrying 1100 gallons of petrol. The total weight of the loaded machine was 14,200 lb., as against the 4750 lb. of Capt. Lindbergh's monoplane, which was of course specially designed for the Atlantic flight. Lieuts. Carr and Gillman came down in the Persian Gulf 45 miles south-east of Bandar Abbas at 8.15 P.M. on May 22. Both airmen were picked up by a passing vessel, but their machine was lost. They appear to have covered about 3500 miles in 30-32 hours.

ON May 4 occurred the centenary of the death of Mark Beaufoy, F.R.S., who assisted to found the Society for the Improvement of Naval Architecture of 1791 and to whom we are indebted for a long series of experiments on the resistance of bodies moving through water. Beaufoy's experiments, described in his "Nautical Experiments," were carried out in the old Greenland Dock and extended over

the years 1793-1798. It is said the experiments cost between £20,000 and £30,000 and that most of this was found by Beaufoy himself. The history of the Society and Beaufoy's work was the subject of a paper to the Institution of Naval Architects by Mr. A. W. Johns in 1910. Beaufoy was born in 1764, and was the son of a brewer. When twenty-three years of age he visited Switzerland and was the first Englishman to climb Mont Blanc, reaching the summit on Aug. 9, 1787, six days later than Saussure. In later life he turned his attention to magnetism and astronomy, and was one of the earliest members of the Royal Astronomical Society, to which his son afterwards presented his instruments.

THE *Proceedings of the Cambridge Philosophical Society, Biological Sciences*, has changed its scope and, under the title of *Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society*, will take the form of critical summaries of recent work in special branches of biological science. The contents of vol. 2, No. 2, give an excellent idea of the aims of the publication in its new guise. It contains three articles, the first of which, by M. Abeloos, deals with the theories of polarity in the phenomena of regeneration. After a review of recent work in this field, M. Abeloos concludes that Loeb's theory of formative substances, if apparently providing a satisfactory interpretation of the facts of regeneration in plants, is insufficient when applied to the animal kingdom. He is of the opinion that the theories of Child alone provide any approach to a complete explanation of the quantitative, qualitative, and physiological aspects of polarity. Dr. F. H. A. Marshall discusses the conditions governing parturition and recent investigations which seem to throw light upon the problem. He shows that parturition is not the result of one or two factors but of a combination of conditions all contributing to the end in question. These conditions are analysed in the light of recent research. In a brilliant review of the mechanics of vertebrate development, Dr. G. R. de Beer summarises the work which has been done and the results achieved in the experimental study of the early development of vertebrates. If this number can be taken as indicative of the aims and scope of the journal for the future, it can be stated at once that it will meet a long-felt want. The articles are comprehensive in character, critical in outlook, and masterly in treatment. Biological workers will welcome such authoritative summaries of current work, and university teachers, in particular, will be grateful for such valuable help in their struggles, often under the most adverse conditions, to keep pace with the bewildering multiplicity of developments in biology and the ever-increasing scope of the science. *Biological Reviews* deserves the support of all workers in this branch of science.

THE annual report of the Institute of Physics for the year 1926, which was received and adopted at the annual general meeting held on May 16, refers to the changes which have been made in the honorary secretaryship and secretariatship of the Institute.

already announced in our columns, consequent upon the resignation of Prof. A. W. Porter and the death of Mr. F. S. Spiers. The report shows a steady increase in the membership of the Institute, and refers to revised regulations for the admission of students which are intended to make the student membership more attractive to those who are not yet in a position to apply for corporate membership. Particulars are also given of the arrangements which are being made at the new offices of the Institute at 1 Lowther Gardens, Exhibition Road, South Kensington, London, S.W.7, whereby the Institute will undertake at the new offices, on behalf of the Physical and Optical Societies, routine work such as correspondence in relation to membership and subscriptions, and the control of stocks and sales of publications. The annual exhibition of the Physical and Optical Societies is included in this arrangement, and the exhibition will in future be organised from 1 Lowther Gardens, and controlled by a committee of representatives of the two societies, to which the secretary of the Institute will act as secretary. A fund for the furnishing and equipment of the offices has been raised largely on the initiative of Mr. Robert W. Paul, chairman of the Finance Committee, and generous contributions to this fund have been made by members of the Institute and by a number of firms. The editor of the *Journal of Scientific Instruments* reports the satisfactory progress of this publication, and announces that under the new editorial arrangements it is hoped to extend the manufacturing sections of the Journal.

THE second of the conversaciones of the Royal Society this year will be held on June 22.

THE Safety in Mines Research Station at Harpur Hill, Buxton, will be opened by Viscount Chelmsford, chairman of the Miners' Welfare Committee, on June 14.

DR. MAX WEBER, emeritus professor of zoology in the University of Amsterdam, who is an authority on marine mammals and fish, and has for many years engaged in oceanographic work, has been awarded the Agassiz Medal by the U.S. National Academy of Sciences.

THE following have been elected honorary members of the Russian Academy of Sciences: Prof. Albert Einstein (Berlin), Mme. Curie (Paris), Prof. W. Nernst (Berlin), Prof. A. A. Michelson (Chicago), and Prof. M. G. Mittag-Leffler (Djursholm, Sweden).

THE tenth Silvanus Thompson memorial lecture of the Röntgen Society will be given at 8.30 on Tuesday, June 14, in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, W., by Sir J. J. Thomson. The subject will be "The Structure of the Atom and Radiation."

DR. E. H. RAYNER will deliver a lecture, to be followed by a discussion, on the solar eclipse of June 29 at a special meeting of the Physical Society, to be held on June 3 at 5 P.M., at the Imperial College of Science and Technology, South Kensington. Fellows of the Society are invited to take friends to the meeting.

AT the annual general meeting of the Manchester Literary and Philosophical Society, the following officers were elected: *President*, Prof. W. L. Bragg; *Vice-Presidents*, Dr. G. H. Carpenter, Dr. O. T. Jones, Dr. H. Leinstein, Dr. R. S. Willows; *Secretaries*, Mr. John Allan, Prof. E. A. Milne; *Treasurer*, Mr. R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. J. C. Withers; *Curator*, Mr. W. W. Haldane Gee.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in agricultural chemistry at the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Essex County Council, Shire Hall, Chelmsford (June 4). A demonstrator in the department of organic chemistry of Bedford College for Women—The Secretary (June 8). A senior and a junior lecturer in comparative anatomy and embryology in the Natural History Department of the University of Edinburgh—The Secretary, The University, Edinburgh (June 10). A lecturer in chemistry in the University of Reading, preferably with physical chemistry qualifications—The Registrar (June 10). An assistant lecturer and tutor in social science at the London School of Economics and Political Science—The Secretary, London School of Eco-

nomics and Political Science, Houghton Street, W.C.2 (June 15). An assistant lecturer in applied electricity at the University College of North Wales, Bangor—The Secretary and Registrar, University College of North Wales, Bangor (June 15). An assistant lecturer in mathematics in the University of Sheffield—The Registrar (June 15). A professor of pathology at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, South Kensington, S.W.7 (June 20). A professor of agriculture and a lecturer in entomology and zoology at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 14 Trinity Square, E.C.3 (June 29). A temporary research officer under the Foot-and-Mouth Disease Research Committee of the Ministry of Agriculture and Fisheries—The Secretary of the Committee, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1. A Secretary and bursar of the South-Eastern Agricultural College, Wye, Kent—The Principal. A research assistant at the Government Laboratory, Porton—The Commandant, Experimental Station, Porton, near Salisbury. Chemists in the establishment of the War Department Chemist, Woolwich—The Permanent Under-Secretary of State, War Office (F.6), London, S.W.1.

Our Astronomical Column.

THE COMING TOTAL SOLAR ECLIPSE.—As an example of the general interest in astronomy that is being awakened by the approaching eclipse, we may mention a pamphlet by Mr. A. J. Hawkes, Borough Librarian at Wigan, in which he gives a list of the astronomical books in that Library, together with particulars and a map of the eclipse track. The map seems to place Wigan too far from the zone of totality; it is placed five miles outside, but the map issued by the Ordnance Survey places it considerably closer. The author seems to be in error in saying that the eclipse of August 1999 will not be total in Cornwall; it is true that calculations have not yet been made using Brown's tables of the moon, but fairly trustworthy calculations indicate that the Lizard and several miles to the north of it will enjoy total eclipse.

The list of books on astronomy is grouped under 23 different headings and occupies 8 pages. It is to be hoped that it may lead to a revival of popular interest in astronomy, such as was awakened by the Norwegian totality of 1896.

NEW DETERMINATIONS OF THE VELOCITY OF LIGHT.—The velocity of light *in vacuo* is a constant of fundamental importance in modern science, and it is necessary that the utmost attainable accuracy should be aimed at in determining its value. Great interest, therefore, lies in the experiments started in 1924 by Dr. A. A. Michelson at Mt. Wilson, with the object of re-determining this important quantity. The method originally employed was to send a beam of light from an octagonal mirror at Mt. Wilson to a station 22 miles distant, whence it was reflected back (by a fixed mirror) to the first mirror, and finally into a micrometer eyepiece. The octagonal mirror was rotated at such a speed that it moved one-eighth of a turn during the journey of the beam of light to the distant station and back (44 miles). The returning beam was thus received on the succeeding facet of the rotating mirror at the same angle as if the latter were at rest. The

velocity of rotation required gave, by a simple calculation, the velocity of light in air. This apparatus has been slightly modified and improved in the later series of observations made by Dr. Michelson. Rotating mirrors of various types are used, some of steel, others of glass, with eight, twelve, and sixteen facets; the results from the different mirrors being in excellent agreement. These latest experiments are described in the *Astrophysical Journal*, vol. 65, p. 1, in which the final value of the velocity of light *in vacuo* is given as 299,796 km./sec. The success so far attained has led to the consideration of an extended base line, and it is hoped to continue the work with a distant mirror on Mt. San Jacinto, 82 miles from Mt. Wilson.

ROYAL ASTRONOMICAL SOCIETY'S ANNUAL REPORT.—The annual report of the Council of the Royal Astronomical Society (*Monthly Notices*, Feb. 1927) contains the usual valuable summary of astronomical progress during the year. In particular a lengthy section by "H. D." on variable stars may be mentioned, which summarises all the important papers published on this subject during the year, and gives copious references. The fact that more than a third of this article is devoted to Cepheid Variables shows that the recent revival of interest in these objects is still being maintained. A valuable innovation has been introduced by "J. A. C." in the sections on solar research and stellar spectroscopy. This consists in a classified bibliography at the end of each section giving references to all relevant papers published during the year, including those not specifically mentioned in the text. This will be appreciated by those specially interested in solar and stellar physics, and is a procedure which might advantageously be extended to the other sections. In addition to the notes on astronomical progress, this issue contains obituary notices of deceased fellows, annual reports of observatories, and the presidential address of Dr. Jeans on the occasion of the award of the Society's Gold Medal to Prof. Schlesinger.

Research Items.

MAORI GAMES.—A valuable monograph by Mr. Elsdon Best on the games and pastimes of the Maori has been published under the direction of the Board of Ethnological Research of the Dominion Museum, N.Z., as Bulletin No. 8. Not only is the account of Maori games given by early travellers meagre, but, owing to the disapproval of these games by the missionaries, notwithstanding their harmless character, few of them survived until the beginning of the present century. Like other features of Maori life, the arts of amusement were attributed to a mythical originator. The practice of the arts of Ruhanui followed the rising of Whanui (the star Vega) when the main crops were lifted. The indulgence in games thus depended to some extent on the leisure afforded by seasonal occupations, but they were also played at night. The recreations may be classified into (1) children's games played at all times; (2) games played at night or at free times when members of two or more families met in a house or on the village plaza; (3) at large meetings such as ceremonial feasts, harvest festivals, etc., when members of one or more sub-tribes gathered together, contests of skill or strength forming a special feature of the occasion; or (4) specially arranged contests between members of different village communities, in wrestling, canoe rowing, dart throwing, posture dancing, and the like. Kite-flying contests were also held. Certain of the games, such as the duels and combats in the school for arms for men, and the posture dances for women, were looked upon not merely as recreation but also as a training for the arts of life, the grace of action, for example, to be acquired through the dance being regarded as an essential in a girl's deportment. The monograph includes in its scope a careful and detailed study of the songs and musical instruments. The Maori did not use stringed instruments, but only wind and percussion.

SUGAR BEET IN ENGLAND.—Mr. G. Turville Brown, in Paper No. 507 of the Surveyors' Institution, gives a full account of the British sugar beet industry. Beginning with a general history of the sugar industry, he shows that the introduction and development of beet sugar in Europe can be traced largely to political conditions, and that the chief reasons why it was not possible to establish its cultivation in England earlier were the facts that the bulk of the beet sugar exported from the Continent, a practice encouraged by European governments with bounties, came to Great Britain, and that British interests were largely vested in the production of cane sugar in the British Empire. The first attempt to introduce the cultivation of sugar beet into England in 1870 was unsuccessful, and even in 1921 the revived industry suffered heavy loss in spite of Government aid. The passing of the Beet Sugar Subsidy Act in 1925, however, details of which are appended to the paper, has resulted in the industry attaining national importance, and in the first year five of the ten factories showed a profit. Although in comparison with countries where the growers are experienced the tonnage obtained is low, the quality and sugar content have been high, and when the farmer has learnt to make the best use of the by-products, namely, the fodder portion of the crop, there is good augury for the success of the industry in Great Britain. With regard to the return which the farmer receives, an average figure based on the prices for 1925 and 1926 shows a £10 profit on a 10-ton crop, without including the feeding value of the residual tops and leaves. Further,

any increase in the cultivation of a profitable root crop would help to check the modern tendency of putting arable land down to grass. As regards climate, England and the lowlands of Scotland are quite suitable for sugar beet, and indeed Great Britain, in being less liable to late frosts, has a distinct advantage over northern Europe. The importance of this is manifest, since much seed-selection work is being carried out in Holland with the view of securing a variety able to withstand late frost without going to seed. Some points with regard to the choice of suitable factory sites, and the methods of working which will secure the greatest possible economy, are included, matters which will prove themselves all the more important to the life of the industry as the subsidy decreases.

AGE AND AREA.—In an article in the *Quarterly Review of Biology* (vol. 1, No. 4) Dr. J. C. Willis replies in part to various criticisms of the age and area hypothesis, and particularly to those of Prof. Fernald in the same journal (vol. 1, No. 2). Many points of difference are involved, some of which cannot at present be settled. For example, as regards rate of distribution, Willis estimates that the wing-fruited *Dipterocarp* trees of Malaya and the Philippines would be dispersed at the rate of 100 miles in 60,000 years, while Fernald points out that nearly the whole of Canada must have been forested from farther south since the retreat of the ice not more than 25,000 years ago. Notwithstanding the rapid dispersal of weeds, Willis concludes that generally whole associations of plants must advance together but with extreme slowness. Again, the need is recognised for distinguishing between local endemics and epibiotics or survivors from a larger area; and the fossil history, which often cannot be traced, must also be considered. Again, it appears that, e.g. in the *Ericas* of South Africa, a wide-ranging northern form has quickly produced a whole series of new local types after reaching what must be regarded as favourable conditions for the genus. Willis insists upon the necessity of treating his results statistically, but it appears unnecessary to make the improbable assumption that new species have generally arisen as the result of a single mutation. His work has brought fresh interest to the old problems of distribution; and further investigations should show in how far time, which no one denies is a factor in dispersal, can be disentangled statistically from the many other factors such as barriers, the rate and conditions of variation, etc., which will play a part in determining the area occupied by a particular species or group of species at a particular time.

TORTOISESHELL CATS.—The tortoiseshell cat remains a genetic anomaly, although the work of Mrs. Bisbee and Miss Catherine Herdman (*Jour. Genetics*, vol. 18, No. 1) sheds further light on the subject. Normally tortoiseshells are females derived from a cross between yellow and black, but in rare cases a male tortoiseshell may occur. Numerous theories have been put forward to explain these and related facts. It appears that either there is a difference in the dominance of black and yellow in the two sexes or both colours are sex-linked. The authors favour the latter view, having found that all yellow cats of either sex have a few scattered black hairs. In the breeding experiments an anomalous yellow female appeared, which showed and transmitted a very small amount of black spotting. This is accounted for by a theory of fractionation of a factor—yellow; the

'anomalous yellow' and black being regarded as a series of multiple allelomorphs.

NEW COTTON SPECIES.—Five new species of cotton have recently been described by Messrs. O. F. Cook and J. W. Hubbard, who give a general account of these primitive cottons in *Jour. of Heredity*, vol. 17, No. 12. They were found among desert vegetation or in door-yards and along roadsides in the provinces of Sonora and Sinaloa in north-western Mexico. One species, *Gossypium Morrilli*, found growing in natural undisturbed conditions in the Yaqui Valley, produces great numbers of bolls and has commercial possibilities. *G. contextum* has the interesting peculiarity that numerous additional fibres form a lining to the inner walls of the carpels, but it is not yet certain that they are actually attached to the wall. Another desert species, *G. davidsoni*, has no lint, but only a short brown fuzz on the seeds. The different types are well illustrated by photographs, and some of them will be useful for crossing with the cottons in cultivation.

AGRICULTURE IN NIGERIA.—The fifth annual bulletin (1926) of the Nigerian Department of Agriculture contains the reports of the various agricultural stations for the previous year, together with a number of papers dealing in detail with some of the investigations in progress at the different centres. A scheme is proposed, which of necessity will extend over a long term of years, the object of which is to increase the production of palm fruit, but social and administrative considerations, arising largely from the manner of ownership of the groves, tend to increase the difficulties entailed in carrying out any improvements. The ground-nut trade is another important industry, but possesses many problems, which if solved would greatly enhance the value of the product. The best time for lifting the crop, and suitable preparation for export, such as efficient decorticating, grading, and packing, are some of the principal subjects under present consideration. An improved method for the extraction of palm oil by natives, the Cooker-Press process, is described and its advantages over the current methods pointed out. Research as to the most suitable preparation of palm nuts before cracking and the subsequent treatment of the nuts and kernels affords another example of investigations which are likely to prove of immense help to the native industries. Variety trials, cultivation and manurial experiments of all kinds, are reported from the various agricultural stations, and fungoid diseases of cotton and, to a less extent, the control of insect pests such as the yam beetle, are being investigated.

WATER AND INDUSTRIAL DEVELOPMENT.—The relation between the quality of the water and manufacturing activity in the United States is discussed by Mr. W. D. Collins in Water Supply Paper 559 (United States Geological Survey). The supply of water is a factor of equal importance with raw materials, power, labour, and transport, in deciding the location and growth of manufactures, and though water can be artificially improved, the cost of so doing is generally too great in manufactures that require large quantities of water of definite quality. A comparison between the location of industries fifty years ago and the present time appears to show that soft water was then more important than it is now, since manufacturing activity has increased most rapidly in States which have hard water. However, Mr. Collins shows that the growth of industry in hard water regions is mainly of two kinds: first, industries

that do not depend on the quality of the water, such as metal and wood industries, canning and preserving, glass and rubber works; and secondly, industries in which numbers of population are more important than any other factor, as flour mills, confectionery, printing, gas-making, etc. The industries dependent on the quality of water, which include chemical, textiles, leather and paper, within the last fifty years have grown almost entirely in those States where the water is soft or only slightly hard, and they do not show any tendency to shift from those regions. The whole subject is treated statistically and illustrated with distribution maps.

IRON ORE IN WESTERN CANADA.—Messrs. G. A. Young and W. L. Uglow have provided an account of the iron ores in the western part of Canada in a recent memoir (Canada. Department of Mines; Geological Survey. Economic Geology Series No. 3: Vol. 1: British Columbia and Yukon. (No. 2093.) 40 cents. Ottawa: F. A. Acland.) It must be admitted that from the economic point of view the report is not particularly hopeful. There are 24 deposits listed believed to contain upwards of 25,000 tons of iron ore; the amount of ore considered to be almost certainly present is only 137,000 tons; the amount of ore probably present is estimated at 1,200,000 tons and the total possible ore contents only 5,000,000 tons; these figures refer to magnetite deposits, of which the greater part of the iron ore deposits in the area discussed consist; with a couple of exceptions of deposits rich in apatite, all the known magnetite deposits are of Bessemer quality. There are also a few deposits of limonite, but these do not appear to be of any great importance. Furthermore, the difficulties of transport in several cases are at present very serious. The report considers that the magnetite deposits of the coast districts must be looked upon as the primary sources of native iron ore that might support an iron-making industry in British Columbia, but evidently the prospects of such an industry being formed on an economic basis do not at present appear to be very promising.

THE ORIGIN OF METEORITES.—In *Gerlands Beiträge z. Geophysik* (1927, pp. 195-222), R. Schwinner discusses the origin of meteorites in greater detail than has hitherto been attempted. He suggests that meteorites cannot be descendants from any part of our solar system, but that they form a cosmic cloud which the solar system entered for the first time in early Quaternary time. This deduction is based partly on the orbits of meteorites and partly on the remarkable fact that no meteorites from beds of Tertiary or older formations have ever been discovered. The origin of the cosmic cloud is ascribed to a collision between two small stars which is estimated to have occurred between 10^{10} and 10^{11} years ago. It is claimed that the structure of meteorites supports the view that they were formed like explosive tufts and that some parts of them cooled rapidly in a weak gravity field. Though meteorites as a whole may provide a kind of cross-section through a formerly existing heavenly body, the supposition that they provide any information as to the interior of the earth must be regarded with extreme caution. As to the origin of tektites, the author is unable to decide whether or not they are of meteoric origin.

FRACTIONAL PRECIPITATION OF BARIUM AND RADIUM CHROMATES.—Several methods are available for the separation of radium and barium by fractional precipitation. In the *Journal of the American Chemical Society* for March, Henderson and

Kracek describe a method of separation by means of the chromates which compares very favourably with the best of those previously employed. In general, the radium-barium solutions were treated with hydrochloric acid followed by definite quantities of potassium chromate solution. Partial separation follows from the fact that barium chromate is appreciably more soluble than the corresponding radium salt. This method may be used with advantage when the radium content of such mixtures is too small to be treated by the chloride method.

CHEMICAL TREATMENT OF FLOUR.—We have received a copy of the Report of the Departmental Committee which has been considering the treatment of flour with chemical substances, published by H.M. Stationery Office (6d. net). Chemical substances are introduced into flour in the first case as bleaching agents, and secondly as improvers, which are said to enhance the natural baking qualities of the flour, which may be deficient in one or more respects. Among these substances are calcium and ammonium acid phosphates, persulphates, chlorine, nitrogen trichloride, nitrogen peroxide, nitrites, and benzoyl peroxide. The Report recommends that when bleaching and improving are necessary the use of chlorine, nitrogen trichloride, and benzoyl peroxide should be avoided. An alternative method of improving by physical means is suggested. By heating wheat or flour at a given temperature for some time, the baking properties are considerably improved, and under certain conditions this flour itself may be used as an improver. At least one mill has discontinued the use of chemical improvers in favour of the physical method.

THERMAL DISSOCIATION OF IODINE AND BROMINE.—The method usually employed for the measurement of the dissociation of iodine and bromine, namely, by measuring the pressure produced by a known amount of halogen sealed in a quartz bulb of known capacity in the presence of an inert gas, has yielded values which are in poor agreement with those predicted by theory. In order to establish with greater certainty the values of the thermal quantities involved, Devries and Rodebush have adapted the method of Knudsen for the determination of vapour pressure by the measurement of the rate of diffusion through a small orifice. Their work is described in detail in the *Journal of the American Chemical Society* for Mar. 1927. The previously accepted value for the entropy of monatomic iodine at 298° K. and 1 atmosphere is 42.6, while the calculated entropy is 40.4. Although the newly determined number is 40.5, Devries and Rodebush consider that the true value of the entropy lies between 42.6 and 40.5, since spectroscopic data indicate that the iodine molecule should possess a magnetic moment and consequently a higher entropy. The calculated entropy of monatomic bromine is 39.0, but this is only approximate, and for this reason no significance can be attached to the agreement of this value with that of 38.2 determined experimentally.

ATOMIC PHYSICS.—The issue of the *Physikalische Zeitschrift* for Mar. 15 contains an address on the present position of atomic physics, delivered by Prof. A. Sommerfeld before the Faculty of Science at Hamburg. One of its objects was to counteract the pessimistic opinion held by many, of the inability of the quantum theories to give a comprehensive view of the physics of matter capable of replacing entirely the electromagnetic theory of thirty years ago. While Heisenberg introduces into his specifications of atomic systems only such quantities as can

be directly observed, Schrodinger and de Broglie in their wave mechanics go behind observed phenomena, and their method has led to great developments in the mathematical treatment of atomic problems. Unfortunately, the new mechanics destroys the sharpness of the picture of the planetary atom to which we have grown accustomed, but the gain in mathematical simplicity is of much greater importance than this loss, and there can be no suggestion of entirely giving up the Bohr theory of the atom.

COMPRESSIBILITY OF HYDROGEN AND NITROGEN.—In view of the number of processes now in use for the production of ammonia from mixtures of hydrogen and nitrogen at pressures from 100 to 1000 atmospheres, data concerning the properties of the compressed gases are of great value. The compressibility isotherms of hydrogen and nitrogen and mixtures of these gases at 0° and pressures up to 1000 atmospheres have been determined at the Fixed Nitrogen Research Laboratory of the American Bureau of Soils by E. P. Bartlett. A quantity of gas at a given pressure and temperature, confined in a heavy steel pipette of known volume, is allowed to expand into a gas burette, and the amount of gas determined by measurement of a fixed volume at a known pressure differing but slightly from atmospheric. Details and the results of this work are given in the *Journal of the American Chemical Society*, Mar. 1927. The compressibility factor of a mixture cannot be calculated from those of the separate gases, since the compressibilities are not linear functions of the composition, but certain empirical equations have been derived connecting these two quantities.

AN ALUMINIUM FILM FILTER IN TELEPHONY.—In a modern telephone system there is a battery of accumulators at the central office which serves as a common reservoir of energy for talking and signalling. It is necessary to charge this battery while it is connected to the system. The alternating components of voice frequency in the output of the charging generator appear as objectionable noise currents in the telephone lines, and therefore great pains are taken to design the direct current generator so as to eliminate all ripples from the voltage wave. This more than doubles the cost of the machines, reduces their efficiency and increases the maintenance cost. In the *Bell Laboratories Record* for April, Mr. Siegmund describes a filtering device which prevents the disturbing ripples from entering the talking circuit even when only a cheap commercial dynamo is used for charging. As condensers having capacities of several thousand microfarads have to be employed, the device would not be economical were it not for the high capacities and the little space occupied by aluminium electrolytic condensers. When an aluminium rod is maintained positive to a suitable electrolyte, a very thin non-conducting film is formed on it which forms the dielectric of the condenser. The electrolytic condenser resembles a single-cell storage battery. The anode plate is corrugated and the cathode plate is flat. They are fastened to the porcelain cover of the jar. For 24-volt operation one jar has a capacity of about 1000 microfarads. They require no routine maintenance. The oscillograph records shown by Mr. Siegmund prove the utility of the device. The properties of the aluminium film have been already used in chemical rectifiers, in lightning arresters and in condensers for power work. Their application in telephony, however, is of particular value at the present time, when the power required for machine switching in automatic systems is growing so rapidly.

What Determines the Resistance and the Tilt of an Aeroplane?¹

By SIR JOSEPH LARMOR, F.R.S.

ONE used to recognise that the exigencies of flight in the tenuous air prescribed a limit to the bulk of a bird, as compared for example with a whale. Yet nowadays every day loads of twenty tons of stuff or possibly far more are carried over long journeys, owing to the power available, solely on wings. How does the attenuated aerial medium find means of supporting such an astonishing mass? To experts the fact is familiar, and so scarcely demands explanation. Indeed, the source of the support in plain terms is just as wonderful as the fact itself. The load is held up solely by the swirl that it produces and leaves behind, and this vertical support must be the only dynamical effect of the swirl when the speed is steady: there remains the question how precisely this result is adjusted. Unfortunately the wakes from screw and wings can scarcely be additive without some mutual interference, though momenta are additive always. For example the spread of the wings is adapted readily to counteract the rotational grip of the screw. Stability is theoretically (G. H. Bryan) another affair.

Whether the supporting medium is air, or water, or even pitch, provided only it is of uniform density everywhere, the momentum, with which the flight is concerned, proves to be expressible at each instant in terms of the distribution of swirl or vorticity alone. Force is experienced by the travelling system equal and opposite to the rate at which momentum is shed away into the wake of its motion. The nature of the swirl passing into the wake thus determines all. In the ideal perfect fluid of abstract hydrodynamics there would be no wake, and therefore no force affecting the translatory motion, though the mass may twirl in permanent precessional spin. If this train of ideas is

right it is impossible for a circulation round the wings of an aeroplane to sustain it, except in so far as it has to be associated with a vortical wake.

The formula for the momentum associated with each element of whirl in the ambient medium, of whatever kind it be and however complex its internal friction, provided only it is of *uniform density*, turns out to be unexpectedly simple. There is translational momentum equal, as applied at any chosen origin, to the vector moment of the mass-vorticity of the element (mass multiplied by spin), combined with rotational momentum around that origin equal to this mass-vorticity multiplied by the square of the distance with sign reversed. Now vorticity has the advantage of being a quality of considerable persistence, unless the internal friction is high: if then this field of spin could be sufficiently explored by observation, it would only be necessary, in order to obtain the forces operating, to trace out the rate at which the derived system of momentum thus associated with the travelling machine is changing. Many special illustrations present themselves. For example, a travelling aeroplane adjusts its presentation so that this moment of momentum, with regard to the point where the pull of the screw intersects the line of weight, is not subject to loss into the wake: such automatic adjustment would tend to nip together the two boundary sheets of the vortical trail, which thus would open out only at the ends of the wings. Again, a windmill parachute appears to be more effective than the simple umbrella type: if so, the cause doubtless declares itself in a wind-channel by the contrasted types of whirl in the wakes they leave behind. And generally, the performance of any propelling screw wholly submerged would be determinable in terms of the whirl in its wake alone, if only that could be explored.

¹ Abstracted, with additions, from *Proc. Cambridge Phil. Soc.*, Feb. 1, 1927, pp. 617-630.

The Wren-Ashmole-Plot Memorial Windows at Oxford.

THE public unveiling of the memorial windows to Sir Christopher Wren, Ashmole, and Dr. Plot by the Chancellor of the University, Lord Cave, took place at Oxford on May 17 in ideal circumstances of weather, after the ceremony of the presentation of honorary degrees to MM. Doumergue and Briand. Speeches were delivered in the Divinity School by the representatives of the bodies who have given the windows. Mr. Madan, on behalf of Brasenose College, spoke on Ashmole as the founder of the oldest museum of natural history; Mr. Guy Dawber, president of the Royal Institute of British Architects, pronounced an éloge on Wren; and the Public Orator, Mr. Poynton, representing University, Magdalen, and Hertford Colleges, made a witty speech on Dr. Plot. The windows are a notable addition to the beauty of the staircase of the Old Ashmolean Museum, and will recall to generations of visitors the great pioneer work of this interesting group of men of science of the seventeenth century, some of whose work is illustrated in the Lewis Evans Collection on the upper floor of the building. The Chancellor expressed the grateful thanks of the University to the respective donors. He also paid a well-deserved tribute to Dr. R. T. Gunther, the Curator of the Lewis Evans Collection of Scientific Instruments, to whose zeal and energy are to be attributed the excellent arrangement and appropriate housing of the Lewis Evans Collection, and at whose instigation the donors of the memorial windows were moved to undertake these admirable

additions to the interest of the historic building that contains them.

The new windows in the Old Ashmolean Building commemorate the work of Ashmole and his three friends, whose collective scientific achievements during the second half of the seventeenth century have proved second to none even in that fertile period of English science. The word collective is used designedly, for it is extremely probable that the labour or good intention of any one member of the group would have been of no avail without the faithful co-operation of the others. They have one and all in their several ways participated in the establishment in Oxford of the first public museum of natural history in Britain. It is meet that so great a public service should be recognised in the building, which fortunately is still standing, a monument to their great work.

The oldest member of the group, John Tradescant, was a great collector, a scientific traveller, a pioneer who introduced new plants into Europe, and followed his father as the owner of the first London museum, at Lambeth. To him succeeded Elias Ashmole, a great transmitter. He realised the supreme educational value of the collection, and on the death of Tradescant, saved it from being scattered by his widow. His social prestige assured its appreciative acceptance by the University, which received the gift with royalty and a banquet, after the expending of a great sum on a building which is not only the finest classical building

in Oxford, but preserves to us Wren's plan for a scientific institution.

With singular appropriateness Oxford is therefore able to accept this memorial window to one of her most distinguished sons of science from the Royal Institute of British Architects. For long before the chance of rebuilding London definitely turned the scientific worker into the architect, Wren had filled the highest scientific post in the University with laudable distinction, and when the Ashmolean Museum was in building he occupied the presidential chair of the Royal Society.

The Tradescant window was presented by the Garden Clubs of Virginia in memory of his great prestige as a gardener and of his fruitful visits to their colony. It was unveiled by Lord Fairfax of Cameron in November last. The Ashmole window is given by the principal and fellows of Brasenose College, of which Ashmole was a member during his sojourn in Oxford. The badge and supporters to the coat of arms, the head of Mercury and the figures of the constellation of the Twins, are emblematic of Ashmole's double interest in astrology and alchemy, with especial regard to Mercury, planet and chemical element. The design has been taken from one of his most treasured books now in the Bodleian Library.

The inscription runs :

ELIAE ASHMOLE
HUIUS MUSEI FUNDATORI
COLL. AEN. NAS. PRINCIPALIS ET SOCIJ
ALUMNO SUO HANC FENESTRAM DEDICAVERUNT
MCMXXV.

The right-hand upper light records the distinguished service of Ashmole's first Keeper of the Museum, Dr. Robert Plot, one of the most remarkable of the Oxford celebrities of his time. He received his early education at University College, whence he proceeded to Magdalen Hall, and when thirty-seven years of age published his "Natural History of Oxfordshire," the work which not only made him famous but also probably suggested Oxford as the best destination for the Tradescant-Ashmole collections. His "Natural History" certainly was the first of its kind, and became the model for many later works. On the strength of a testimonial from John Evelyn, Ashmole in 1683 appointed Plot as his first Keeper of the Museum, a position that he filled for seven years, combining the duties with those of professor of chemistry and of secretary to the Philosophical Society of Oxford.

Towards the end of his life, Plot, elected to the office of Mowbray Herald, seems to have adopted the coat of arms in the new window. The surrounding wreath is of two Oxfordshire flowers which Plot was the first to recognise as new to the British flora. They are the marsh violet (*Viola palustris*) and the "Greatest Dove's foot Crane's-bill with dissected leaves" (*Geranium dissectum*). The happy dedicatory inscription runs :

ROBERTUS PLOT R.S.S.
HUNC CELEBRANT COLLEGIA NOMEN ET ARTEM
TRADITA MUSEI EST PRIMO CUSTODIA PRIMI.

In the right-hand lower light are emblazoned the arms and crest of Sir Christopher Wren, with two swags of foliage and contemporary scientific instruments familiar to astronomers and navigators at the time when, as Savilian professor of astronomy, Wren doubtless taught their theory to his pupils. The instruments comprise the mariner's astrolabe, cross-staff, backstaff, astronomical ring dial, and nocturnal, all very carefully studied and drawn upon the glass. Of special interest is the drawing of Wren's own pair of compasses,

now in the possession of the Royal Society, and the only example of his many instruments that has come down to us. A cartouche below contains the dedicatory inscription recording the circumstances of the presentation of this window by the Royal Institute of British Architects.

CHRISTOPHERUM WREN

ASTRONOMIAE PROFESSOREM SAVILLIANUM
COELESTIBUS EXSTRUCTIONIBUS NOBILEM COMMEMORAVIT
REGALIS SOCIETAS ARCHITECTORUM BRITANNICORUM
MCMXXVII

In a letter to the *Times* for May 23, the anniversary of Ashmole's birthday, Mr. E. B. Knobel expresses the hope that these armorial windows may be supplemented by one to Dr. Lewis Evans, whose gift has led to the revival of the Old Ashmolean.

University and Educational Intelligence.

CAMBRIDGE.—Dr. G. F. C. Searle, Peterhouse, has been reappointed University lecturer in experimental physics, and Mr. C. Warburton, Christ's College, has been reappointed demonstrator in medical entomology.

LONDON.—At a meeting of the Senate on May 18, the Vice-Chancellor stated that with reference to the anonymous offer, already announced, of £10,000 towards the establishment of a chair of dietetics, Messrs. A. Wander, Ltd., had now intimated their desire to contribute a similar sum to the same object.

It was announced that a donor who desires to remain anonymous has offered £250 as a contribution towards any preliminary expenses involved in the preparation of a comprehensive plan for the development of the Bloomsbury site.

Mr. D. MacC. Blair, lecturer in regional anatomy in the University of Glasgow, has been appointed as from Aug. 1 to the University chair of anatomy tenable at King's College.

Dr. G. S. Wilson has been appointed as from Oct. 1 to the University readership in bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine. Dr. Wilson was educated at Epsom College, King's College, London, and Charing Cross Hospital. In 1919 he was appointed specialist in bacteriology at the Royal Army Medical College; in 1921 he became assistant in bacteriology under the Medical Research Council. In 1923 was appointed lecturer in bacteriology in the University of Manchester, and since 1925 he has been assistant director of the Public Health Laboratory, Manchester.

The following doctorates were conferred: D.Sc. in Botany on Mr. P. Sarbadhikari (Imperial College—Royal College of Science) for a thesis entitled "Cytology of *Osmunda* and *Doodia*—On the Gametophyte and Post-meiotic Mitoses of the Gametophytic Tissue of *Doodia*;" and D.Sc. (Economics) on Mr. G. C. W. C. Wheeler (London School of Economics) for a thesis entitled "Mono-Alu Folklore."

The Dunn Exhibitions in anatomy and physiology were awarded to Mr. K. M. Robertson, of St. Thomas's Hospital Medical School.

THE Society for the Advancement of the Training of Mechanics, Leyden, announces vacation courses for mechanics and glassblowers in August next at the Physical (Cryogenic) Laboratory of the University of Leyden. Full particulars can be obtained from Dr. C. A. Crommelin, the Physical Laboratory, Leyden, Holland.

By the will of Lady (Charles) Henry, of Carlton Gardens, London, S.W., a large sum of money will become available for the foundation of scholarships

at Oxford and Cambridge for American students and at Harvard and Yale for British students. The scholarships will be open to both sexes and are to be available for undergraduate as well as post-graduate courses. The Charles and Julia Henry Fund, as it will be termed, is to be administered by twelve trustees, three each being appointed by the four universities concerned, who will have wide discretionary powers. The whole of the residuary estate, estimated at £300,000, goes to the fund.

PARTICULARS of vacation courses in England and Wales, 1927, are given in a pamphlet (London, H.M. Stationery Office. 6d.) issued by the Board of Education. Courses for teachers have been arranged: by the Board itself, to be held at Oxford, Cambridge, London, Durham, Birmingham, Nottingham, Bangor, Brighton, Eastbourne, and Studley; by the local education authorities of Brighton, Carmarthen, Cheshire, Glamorgan, Hertford, Kent, and Yorkshire (West Riding); and by five teacher-training institutions. Courses for foreigners are offered by the Universities of London and Cambridge. The University Extension summer meeting will be at Oxford, and there will be the usual university tutorial class summer schools in connexion with all the universities except Reading. Among the various courses offered at Bingley by the West Riding County Council is one by Mr. Stanley Jast on the library and the school. The National Museum of Wales is giving a course on methods of caring for exhibits. Some thirty courses in their special subjects are offered by various voluntary associations. Summer Schools of the League of Nations Union are to be held at Oxford (St. Hugh's College, July 27-Aug. 5) and Geneva (Geneva Institute of International Relations: elementary, July 30-Aug. 5; advanced, Aug. 6-Aug. 12). At Oxford, Lord Hugh Cecil will give the inaugural address, and there will be a preliminary conference of teachers on July 27-29, opened by the Right Hon. H. A. L. Fisher.

APPOINTMENTS made by the Committee of Award for the Commonwealth Fund Fellowships to the twenty Fellowships tenable by British graduates in American universities for the two years beginning in September 1927 include the following: Mr. J. M. Alston (Edinburgh), to Harvard University, in medicine; Mr. Maurice Black (Trinity College, Cambridge), to Princeton University, in geology; Mr. G. F. Brett (Leeds), to the University of Michigan, in physics; Mr. David Graham (Queen's University, Belfast), to the Massachusetts Institute of Technology, in electrical engineering; Mr. F. T. Hewer (Bristol), to Johns Hopkins University, in medicine; Mr. M. I. Hutton (Glasgow University and Balliol College, Oxford), to Yale University, in economics; Mr. Eric F. Nash (University College, Oxford), to Harvard University, in economics; Mr. R. A. C. Oliver (Edinburgh), to Stanford University, in education; Mr. A. Oppenheim (Balliol College, Oxford), to the University of Chicago, in mathematics; Mr. R. Robinson (Birmingham), to the University of Pennsylvania, in physical chemistry; Miss E. Simkins (Liverpool), to Clark University, in geography. This year the Commonwealth Fund has established three extra fellowships, primarily intended for candidates from British Dominions who have studied at British Universities. Nominations to these Fellowships include the following: Mr. H. I. Coombs (Adelaide University, Magdalen College, Oxford, and Trinity College, Cambridge), to the Rockefeller Institute, New York, in physiology; Mr. Reginald Jackson (University of South Africa and Trinity College, Oxford), to Harvard University, in philosophy.

Calendar of Discovery and Invention.

May 29, 1453.—From some points of view the fall of Constantinople, which took place on May 29, 1453, may be regarded as contributing directly to the birth of the modern age of scientific inquiry and discovery. When, after a siege of 53 days, Mahomet II. gained possession of the city, many Greeks fled into Europe, carrying with them the precious manuscripts of ancient Greek authors. Included in these were mathematical works which were translated and soon afterwards made available through the invention of the printing press.

May 29, 1624.—The first legislative enactment for regulating the granting of industrial monopolies was The Statute of Monopolies (21 Jac. I. c. 3) passed by the English Parliament on May 29, 1624. The Statute was not, as has often been assumed, the foundation of the English patent law; it merely gave parliamentary sanction to principles, already accepted at common law, which now form the basis of all patent laws throughout the world. Its purpose was to prevent the Crown from granting oppressive monopolies, but in the famous section 6 it exempted from the general prohibition the granting of patents for the encouragement of new inventions. This section is still in force.

May 31, 1836.—The introduction of screw propulsion was due to many pioneers, of whom, however, the foremost was Francis Pettit Smith. Smith's first patent was taken out on May 31, 1836, and he described his invention "to consist of a sort of screw or worm made to revolve rapidly under water, in a recess or open space formed in that part of the after part of the vessel, called the dead wood or dead wood of the run." His screw was tried successfully in the s.s. *Archimedes*, the first screw vessel to navigate the open seas.

May 31, 1919.—On the afternoon of May 31, 1919, the American seaplane NC4, piloted by Lieutenant-Commander A. C. Read, arrived in England, having since May 16 flown in three stages from New York to the Azores, thence to Lisbon and to Plymouth. She was the first machine to fly across the Atlantic.

June 1, 1785.—Cavendish in his study of the atmosphere used many methods, and some of these he described to the Royal Society in his paper, "Electric Discharges through Air," read on June 1, 1785.

June 1, 1894.—One of the landmarks in the early history of radio signalling was Sir Oliver Lodge's lecture at the Royal Institution on June 1, 1894, on "The Work of Hertz," when, with the aid of a Branly's coherer of filings, signals were detected at a distance from the transmitting apparatus.

June 1, 1906.—Five tunnels pierce the Alps—the Mont Cenis, the St. Gothard, the Arlberg, the Lotschberg, and the Simplon. Of these the Simplon is the longest and deepest, being 12½ miles long and more than 7000 feet below the surface. Begun in 1898, it was opened on June 1, 1906. It was bored simultaneously from both ends, and when the two tunnels met, the error of alignment was only 3½ inches.

June 2, 1881.—The famous test of Pasteur's views on the efficacy of vaccination of animals for anthrax culminated on June 2, 1881, at the farmyard of Pouilly le Fort. Twenty-five vaccinated and twenty-five unvaccinated sheep had previously been inoculated with some very virulent cultures of the anthrax bacillus. On June 2, Pasteur and others visited the farm. "The carcasses of twenty-two unvaccinated sheep were lying side by side; two others were breathing their last. . . . All the vaccinated sheep were in perfect health. . . . The one remaining unvaccinated sheep died that same night."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 19.—Lord Rayleigh: Studies of the mercury band spectrum of long duration. The stream of vapour is excited by a current of less than a milliampere, using a hot cathode. It is then observed spectroscopically after leaving the region of discharge. As in previous investigations, the resonance line $\lambda 2537$ is associated with the band spectrum, but the resonance line $\lambda 1850$ is absent. The important divisions of the band spectrum are: (a) The band at $\lambda 2345$, with attendant bands of shorter wave-length; (b) the resonance line $\lambda 2537$, with bands within a few Ångströms of it; (c) the fainter maximum at $\lambda 2650$, and a series of flutings which are made out with difficulty but seem to be associated with it; (d) the broad maximum at $\lambda 3300$; (e) the broad visual maximum. When the vapour is examined *after excitation* all these features decay *pari passu*. The actual time taken to decay to half intensity under the conditions is 1.82×10^{-3} second. If the excited stream of vapour is passed through a tube locally heated to redness, the band (e) is extinguished, (a) and (c) are slightly weakened, but (b) and (d) are almost unaffected. As the vapour passes on to the cold part of the tube the visual light (e) reappears to some extent, and (a) and (c) tend to regain their intensities relative to (b) and (d).

A. Fowler and L. J. Freeman: The spectrum of ionised nitrogen (N II). Observations have been made over the range $\lambda 6836$ to $\lambda 830$. Of 340 lines recorded in this region, about one-half have now been classified, and of the remaining lines more than 100 are very faint. The spectrum is built up from triplet and singlet terms. The scheme of terms deduced from the Heisenberg-Hund theory of complex spectra has greatly facilitated the analysis of the spectrum. Of the 19 deepest terms predicted for transitions of a single electron, complex terms being counted as one, all but one have been identified. The term 1^3P_0 recently identified by Bowen from a multiplet at $\lambda 671$ is probably the deepest, its value being 238850, corresponding to an ionisation potential of 29.5 volts. A few multiplets which appear in the spectrum are attributed to double electron transitions.

O. W. Richardson: The hydrogen band spectrum: new band systems in the violet. This paper describes the *Q* branches of some band systems which include much of the strength of the secondary hydrogen spectrum when this is excited by direct electron impact on the H_2 molecule and there are no additional complications. The final states of the bands appear to be the same as the initial states of the Lyman bands in the far ultra-violet (the *B* states of Dieke and Hopfield). All the bands are degraded towards the violet. The strongest band system, denoted by *A*, has its nucleus ($0 \rightarrow 0Q(1)$ line) at $\lambda 4633.95(9)$. The *Q* branch of the $1 \rightarrow 0$ band is the series $20Q(m)$ of Richardson and Tanaka. There is a less strongly developed band system (*B*) with its nucleus at $3684.38(2)$ and a few $Q(1)$ lines of a system (*C*) with its nucleus at $3368.47(0)$. *A*, *B*, and *C* all have the same set of final states. The terms are $2S = 33727.12$, $3P = 12676.47$, $4P = 7087.66$, $5P = 4514.14$. They are very close and similar to the corresponding terms of the principal series of He *singlets* but rather larger.

O. W. Richardson: Note on a connexion between the visible and ultra-violet bands of hydrogen. There is evidence in the visible secondary hydrogen spectrum of the existence of bands the final states of which are the same as the initial states of the bands found by Werner in the Lyman region. Some of the con-

sequences of this are discussed, including a recalculation of the moment of inertia of the normal hydrogen molecule. The value found is 4.5×10^{-41} gm. cm.²

C. N. Hinshelwood and P. J. Askey: Homogeneous reactions involving complex molecules. The kinetics of the decomposition of gaseous dimethyl ether. In the decomposition of dimethyl ether to form carbon monoxide and hydrogen the reaction is unimolecular at pressures above about 400 mm. At lower pressures it ceases to be independent of the initial pressure. The hydrogen seems to act only by maintaining the Maxwell distribution among the molecules of ether, when this would otherwise be disturbed by the chemical transformation of activated molecules; for it can only restore the rate of reaction to its normal limiting value and cannot increase it beyond this. Nitrogen, helium, carbon monoxide, and carbon dioxide do not have a similar influence.

W. G. Palmer: An experimental test of the dipole theory of adsorption. The electric coherer functions normally when the loose contact is immersed in liquids, and the cohering voltage increases regularly in the homologous series of primary alcohols, fatty acids, and their ethyl esters, according to the rule $E^2/l = \text{constant}$, where l is the length of the chain. This result indicates that the energy of desorption in a given series is proportional to the square of the electric moment of the adsorbed molecule, and supports the dipole theory of adsorption.

Sir Robert Hadfield: Thermal changes in iron-manganese alloys low in carbon. The temperature at which the final recovery of magnetism occurs on cooling, with its accompanying evolutions of heat, is progressively lowered with increasing manganese percentage. The transformation, however, becomes gradually weaker in intensity and finally vanishes while still at a temperature of about 100°C ., and at a manganese percentage just short of that at which non-magnetic qualities are reached, namely, 16 per cent. Thus the explanation that the alloys exceeding this percentage owe their non-magnetic qualities to their critical change points being below atmospheric temperature, is not tenable. The present work gives further support to the belief that the suppression of the magnetic qualities of the iron may be due to its actual combination with the manganese.

K. S. Krishnan and C. V. Raman: The magnetic anisotropy of crystalline nitrates and carbonates: Crystals of sodium and potassium nitrates exhibit a marked diamagnetic anisotropy, the susceptibility perpendicular to the plane of the NO_3 -ion being greater than for directions in the plane; the difference of susceptibility in the two directions is the same for the two crystals. Attributing this anisotropy to that of the NO_3 -ion, its magnitude is exactly what we should expect from the known value of the magnetic birefringence (Cotton-Mouton effect) of nitric acid liquid. An explanation is suggested on the basis of its electronic structure; the CO_3 -ion, which has essentially the same structure, gives almost the same anisotropy.

C. G. Darwin: The Zeeman effect and spherical harmonics. The problem of a spinning electrified sphere moving in a central orbit in a magnetic field is solved in spherical harmonics by the method of the wave mechanics. It leads to a set of simple arithmetical equations which give exactly all the features of the standard Zeeman effect in all strengths of field. Strictly the model only yields the odd multiplicities, but the same system of equations is just as competent to give the even.

D. Jack: The band spectrum of water vapour. Evidence on the nature of the emitter of the water vapour bands is in favour of the OH ion. The band

2608 is similar in structure to the others and leads to the same final moment of inertia as the bands 3064 and 2811. The scheme of bands suggested by Dieke has been extended, and verified by taking differences of the wave numbers of corresponding lines in the various bands.

L. S. Ornstein, H. C. Burger, J. Taylor, and W. Clarkson: The Brownian movement of a galvanometer coil and the influence of the temperature of the outer circuit. A particular form of theory suitable to the requirements for the more complicated case of a galvanometer having an external inductance L , of ohmic resistance r , at an absolute temperature T^0 , is developed.

W. A. Bone and D. M. Newitt: Gaseous combustion at high pressures (Part vii.). A spectrographic investigation of the ultra-violet radiation from carbonic oxide—oxygen (or air) explosions. The resultant ultra-violet radiation from $2\text{CO} + \text{O}_2 + 4R$ explosions at corresponding high initial pressures, where R is a diatomic diluent, is much less when the latter is carbon monoxide or nitrogen than when it is oxygen; this result indicates that the former strongly absorbs the ultra-violet radiation emitted by the burning carbon monoxide in such circumstances. The marked nitric oxide formation which always occurs in a carbon monoxide excess-air explosion at an initial pressure of 25 atmospheres does not take place during the actual combustion, but after all the resulting radiation capable of effecting a sensitive photographic plate has been emitted. When nitric oxide is present during the actual combustion period in such an explosion, a definite absorption band spectrum is superposed upon the characteristic continuous ultra-violet spectrum of the burning carbon monoxide. The resultant ultra-violet radiation from a $2\text{CO} + \text{O}_2 + 4R$ explosion at an initial pressure of 14 atmospheres is very much stronger than that for a $2\text{CO} + \text{O}_2 + 4\text{He}$ explosion at the same pressure, although the maximum temperatures attained in the two cases differ by 130°C . only.

O. W. Richardson and M. Brotherton: Electron emission under the influence of chemical action at high pressures, and some photoelectric experiments with liquid alloys. The reaction investigated is that of COCl_2 at pressures not less than 0.001 mm . on drops of the liquid alloys of sodium and potassium. The electric currents are (1) proportional to the rate of drops (2) independent of the pressure of COCl_2 over a wide range. The distribution of velocity among the higher velocity electrons is Maxwellian: there is no sharp limit as in the photoelectric effect. The average energy is equivalent to a temperature of 2370°K . The chemical currents can be used to determine the contact potential between the drops and a second electrode. The results seem to agree with the hypothesis that the chemical action is propagated sideways at the edges of infected patches.

P. A. M. Dirac: The quantum theory of dispersion. One can consider a field of radiation to be a dynamical system whose canonically conjugate variables are the energies and phases of its Fourier components. One can then describe its interaction with an atom by a Hamiltonian function and obtain a satisfactory quantum theory of all radiative processes. The theory, when applied to the scattering of radiation by an atom, shows that two kinds of scattering processes can take place, namely, single processes for which a light-quantum simply changes its direction of motion, and double processes which are combinations of an absorption and emission. The sum of the two, when account is taken of their mutual interference, gives (excluding the case of resonance) just Kramers' and Heisenberg's dispersion formula. When the incident

frequency coincides with that of an absorption line, practically the whole of the scattered radiation comes from transitions to the higher state and down, again governed by Einstein's laws.

Royal Microscopical Society¹ (Liverpool Conference), Mar. 30 and 31.—Eric Ponder: The diameter of the red cells of man before and after exercise. The red cells of man, or of any animal, may be measured without being brought into contact with any atmosphere other than one which is in equilibrium with the blood from which the cells are derived (technique of Dryerre, Millar, and Ponder). The preparations of cells, immersed in the plasma of the subject whose cells are to be measured, are made in a special chamber containing a gas mixture in equilibrium with the blood at rest or after exercise, as the case may be, the gaseous tensions of this blood being determined by preliminary analyses. These preparations are then photographed, and the diameter of the cells determined from the plates. There appears to be no difference in the mean diameter of the cells of the same individual before and after severe exercise.—W. Ramsden: Surface phenomena. Aqueous solutions of many organic solids of high molecular weight can be made to yield visible solid masses by treating them in such ways as will sweep up any particles present on their air-surfaces. The solutes used are solids which diminish the tension of a water-air surface, and the heaped-up surface-particles are termed 'massed adsorpta.' With the three proteins egg-albumin, fibrinogen, and edestin, the massed adsorpta undergo irreversible coagulation and are insoluble in the mother liquids. With all other substances tested, including in these very many proteins, the massed adsorptum rapidly goes back into solution. The 'adsorptum-coated' surfaces are in some cases freely mobile (sodium oleate, bile-salts, quinine). In other cases (nearly all proteins, and saponin) sulphur grains or magnets floated on the surface are mobilised. All solutions capable of being blown into more than fugitive bubbles, or of forming stable emulsions with oils, contain solutes adsorbable at the interfaces concerned.—J. Ross-Mackenzie: The causes and correction of cloudiness in malt liquors. Brewing materials are extremely complex in composition, and the ever-changing character of nitrogenous substances produces cloudiness. The permanently soluble nitrogenous constituents are divided into two groups, 'assimilable nitrogen' and 'non-assimilable nitrogen.' The amount and type of assimilable nitrogen absorbed depends on the class of yeast used. A beer produced from British barley-malt and hops only would contain an excess of crude nitrogen; to overcome this excess the brewer is compelled to employ materials free from nitrogen as diluents. Composite yeasts are mainly used in breweries and 'wild yeasts,' in excess, are the main cause of cloudiness, abnormal flavours and odours, and general instability in beers.—A. C. Thaysen and H. J. Bunker: Some observations on the microscopical study of deteriorated fabric from early Egyptian tombs. Swabs were taken in the sepulchral chamber of Tut-an-kh-amen's tomb immediately after opening and were tested for live bacteria and fungus spores. Though such were undoubtedly present when the tomb was sealed, no viable spores existed. Linen fabrics from this tomb and that of Queen Hetepheres, circa 3000 B.C., was examined to determine the cause of tendering. Probable fungus spores and fragments of mycelium were found in the Tut-an-kh-amen material, but on swelling the fibres with sodium hydroxide, the appearance was typical of that produced when tendering is caused by

¹ Continued from p. 766.

chemical agencies. It seems that though microbiological activity occurred on the fibres to a limited extent and in localised areas, such action ceased comparatively soon after the sealing of the tomb and was superseded by a different type of deterioration, usually referred to as 'ageing.'

DUBLIN.

Royal Irish Academy, April 25.—E. J. Sheehy: The relative food values of brown (from entire wheat grain) and white (from endosperm of grain) wheaten flour, and their comparative potency for the prevention of xerophthalmia in guinea-pigs. Results of prolonged feeding experiments on guinea-pigs with restricted diets bear evidence of the superiority of brown over white flour as regards the content of vitamin A. Xerophthalmia appears earlier and more frequently in the group of animals fed on white flour and mangels than in the brown flour and mangel lot. The progress made by the group of animals fed on mangels, brown flour, and hydrogenated soya bean oil is similar to that made by those animals fed on mangels, white flour, and cod-liver oil.

Royal Dublin Society, April 26.—W. R. G. Atkins: The soluble silicate content of soils. The colorimetric method of Diénert and Wandenbulcke may be used to estimate the soluble silicate in an aqueous extract. Calculated on the weight of the air-dried soil the silicate, as SiO_2 , was found to vary from 18 to 124 parts per million. No constant relation was observed between these figures and those for electrical conductivity or pH values, but the soils used had been stored.—M. Grimes, H. S. Boyd Barrett, and J. Reilly: Methylene blue (reductase test) in milk grading.

EDINBURGH.

Royal Society, May 9.—D. Noël Paton: Submergence and postural apnoea in the swan. An investigation of the apnoea in the swan in feeding, showing that it is postural and that both labyrinthine and neck reflexes are involved.—H. Graham Cannon: On the feeding mechanism of *Nebalia bipes*. *Nebalia* is a mud-living form feeding on food filtered from an antero-posterior food stream produced by the oscillatory movements of its trunk limbs. The latter are armed along their inner edges with four rows of setae. The first and third rows are hooked and those of successive limbs interlock, forming a continuous filter wall. The fourth row are stiff setae which comb the filtered food off the filter walls, and the second are brush setae which sweep the food so gathered forwards to the mouth. The mouth parts both functionally and structurally resemble those of a mysid, and *Nebalia* probably arose from such a primitive form that took to mud-living habits, the foliaceous limbs having developed in correlation with this new habitat.—A. H. R. Goldie: The structure and movement of the atmosphere as affected by diurnal variations. The main processes are (a) gravitational mass convection, transferring heat upwards in accordance with Sandstrom's principle, which would in the long run lead to extreme stability in the vertical direction and great frequency of inversions were it not for the operation of (b), the waves and vortices due to discontinuous motions, however local, which operate to transfer heat downwards or horizontally at the cost of some of the energy of the general horizontal circulation and tend to obliterate the discontinuities. The final result is a stratification of the atmosphere with a fair degree of 'resilience' and in particular a semidiurnal variation; turbulence, initiated in the forenoon by such solar

radiation as reaches ground level and initiated in the evening mainly by outgoing radiation from cloud masses or from air masses raised convectionally in the morning, leads at these times to a certain amount of mixing of layers with consequent retardation; on the other hand, in the late afternoon and the latter part of the night the laminarity of flow is improved.—A. W. Greenwood and F. A. E. Crew: On the quantitative relation of comb size and gonadic activity in the fowl. The law of 'all-nothing' formulated by Pezard does not hold in the case of comb volume. The degree of development of head furnishings is dependent not on the amount but on the degree of spermatogenic activity of the gonadic tissue.

ROME.

Royal National Academy of the Lincei, Mar. 6.—L. Tonelli: An approximation polynomial and the area of a surface.—C. Somigliana: Determination of geodic constants by means of measurements of gravity alone.—O. M. Corbino: Realisation of high positive and negative self-inductions by means of a three-electrode lamp and induction circuits.—A. Lo Surdo: The saturation current of thermionic valves. Experiments with various thermionic valves show that, in the phase of saturation, the current intensity is not constant but varies very nearly in proportion to the potential difference between the plate and the filament. Moreover, for any temperature of the filament of any one valve, the increases of the saturation current corresponding with definite increments of the anode voltage are, within wide limits, approximately constant fractions of the respective currents.—J. M. Burgers: Some investigations of Helmholtz and of Wien relating to the form of the waves at the surface of separation between two liquids.—L. Fernandes and F. Palazzo: Investigations on sulpho-salts (ii). Sulphoxypolymolybdates of ammonium and of guanidine. Treatment of the solution of a normal sulphomolybdate with even a relatively weak acid, such as acetic or formic acid, results in decomposition of the salt with evolution of hydrogen sulphide and precipitation of molybdenum sulphide. On the other hand, the sulphony-salts, although they are decomposed by strong mineral acids, undergo polymerisation similar to that experienced by the oxygenated salts under the action of weak acids in low concentration. A number of ammonium and guanidine sulphonypolymolybdates have been prepared in this way.—Remo de Fazi: Alcoholic fermentation of glucose solutions exposed to the action of ultra-violet rays. When a glucose solution is exposed to the rays emitted by a quartz mercury vapour lamp, its optical rotation remains unchanged, but its subsequent fermentation by yeast is accelerated, often considerably, and the final liquid is appreciably more free from bacterial contamination than the untreated solution similarly fermented.—G. Cotronei: New observations on the influence of the nervous system in relation to nutrition with thyroid in the morphogenesis of the *Anura amphibia*.—P. Pasquini: Investigations on the experimental embryology of the echinoderms (i). Atypical segmentation and successive development of the egg of *Arbacia punctulata* (Grey) centrifuged after fertilisation. The resistance of the egg of *Arbacia* to centrifugal force is immediately modified by fertilisation, the plasma becoming more sensitive in some respects.—U. D'Ancona: Investigations on the increase in size of the eye of the eel in relation to sexual maturity, and considerations on its biological significance.—L. Volterra D'Ancona: Further as to the variability of the pelagic *Daphnia* of Lake Nemi.

Official Publications Received.

BRITISH.

- Hull Museum Publications. No. 145: Record of Additions, No. 70. Edited by T. Sheppard. Pp. 47. No. 146: Hull's Art Treasures. By T. Sheppard. Pp. 53+15 plates. No. 147: Catalogue to the Hull Printing Trades Exhibition, held at the Museum of Commerce and Transport, High Street, Hull, from March 17th to April 9th, 1927. Pp. 40+xxvii. (Hull.)
- Canada. Department of Mines: Mines Branch. Helium in Canada. By R. T. Elworthy. (No. 679.) Pp. iv+64+2 plates. (Ottawa: F. A. Acland.) 20 cents.
- Aeronautical Research Committee: Reports and Memoranda. No. 1055 (Ae. 238): Tests on Handley Page Aerofoil A.1. and R.A.F. 31. Communicated by Messrs. Handley Page, Ltd. (A.S.a. Aerofoils General, Ltd.) Pp. 33+11 plates. 1s. 3d. net. No. 1058 (Ae. 240): D. M. Smith's method for the determination of the Frequencies of Vibration of Uniform Beams. By T. W. K. Clarke and V. M. Falkner. (D.I. Special Technical Questions, 180.—T. 2395.) Pp. 9+2 plates. 9d. net. No. 1067 (Ae. 249): On the Contraction of the Slipstream of an Airscrew. By H. Glauret. (A.3.d. Airscrews, 90.—T. 2237.) Pp. 11. 6d. net. (London: H.M. Stationery Office.)
- University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant 1925-1926. Pp. 24. (London: H.M. Stationery Office.) 8s. net.
- Pharmaceutical Society of Great Britain: Pharmacological Laboratories. First Annual Report, 1926. Pp. 7. (London.)
- Journal of the Royal Statistical Society. Vol. 90, Part 2. Pp. x+235. (London) 7s. 6d.
- The University of Leeds: Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor for the Sessions 1924-25 and 1925-26. Pp. 14. (Leeds.)

FOREIGN.

- Proceedings of the Imperial Academy. Vol. 8, No. 2, February. Pp. iii+iv+45-114. (Uyeno Park, Tokyo.)
- University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 4: Arrow Release Distributions. By A. L. Kroeber. Pp. 283-296. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 25 cents.
- Columbia University. Bulletin of Information, Twenty-seventh Series, No. 19: Professional Courses in Optometry; Announcement 1927-1928. Pp. 80+8 plates. (New York City.)
- United States Department of Agriculture. Department Bulletin No. 1472: Chemotropic Tests with the Screw-Worm Fly. By D. C. Parman, F. C. Bishopp, E. W. Laake, F. C. Cook and R. C. Roark. Pp. 32. (Washington, D.C.: Government Printing Office.)
- Department of the Interior: U.S. Geological Survey. Water-Supply Paper 550: Surface Water Supply of the United States, 1922. Part 10: The Great Basin. Pp. v+192+2 plates. 10 cents. Bulletin 790-B: The "Palouse Soil" Problem, with an Account of Elephant Remains in Wind-Borne Soil on the Columbia Plateau of Washington. By Kirk Bryan. (Contributions to the Geography of the United States, 1926.) Pp. ii+21-45+plates 4-7. (Washington, D.C.: Government Printing Office.)
- Proceedings of the United States National Museum. Vol. 71, Art. 1: Description of a new Species of Fresh-water Copepod of the Genus *Morania* from Canada. By Arthur Willey. (No. 2673.) Pp. 12. Vol. 70, Art. 4: Miscellaneous Descriptions of new Parasitic Hymenoptera, with some Synonymical Notes. By A. B. Gahan. (No. 2676.) Pp. 39+1 plate. Vol. 71, Art. 6: A new Genus and Two new Species of South American Fresh-water Mussels. By William B. Marshall. (No. 2678.) Pp. 4+2 plates. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

- The West Indies: being a Catalogue of Books, Maps and Engravings relating to British and Foreign Possessions in the West India Islands. (No. 495.) Pp. 42. (London: Francis Edwards.)
- Catalogue of Secondary and Higher Text-Books. Pp. iv+208. (London: G. Bell and Sons, Ltd.)
- Errata List No. 1. Pp. 8. Circular 251A: Laboratory Coats, Aprons and Short Jackets. Pp. 2. Circular 258A: Standard Volumetric Glassware. Pp. 2. Circular 255: The "Alltest" Multi-Range Portable Moving Coil Instrument. Pp. 2. Circular 256: New Electrical Apparatus for the Determination of Molecular Weights by Rast's Camphor Method. Pp. 1. Circular 262A: Monax Laboratory Glassware. Pp. 4. "Scholix" Beakers and Flasks. Pp. 3. (London: A. Gallenkamp and Co., Ltd.)
- Illustrated Price List of Apparatus for Radiology (Abridged). 1927 edition. Pp. 64. (London: Newton and Wright, Ltd.)
- Rare and Valuable Books. (No. 17.) Pp. 126. (Newcastle-on-Tyne: William H. Robinson.)

Diary of Societies.

SATURDAY, MAY 28.

- INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District Meeting) (at Town Hall, Newport), at 8.30 A.M.
- NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 8.—W. S. Armstrong: Variable Speed Gears and their Application for Colliery Purposes.—Paper open for further discussion: The Ventilation of a Fyrites Mine, with Special Reference to Fire-Fighting, Safety and Rescue-Work, R. White.

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MONDAY, MAY 30.

- VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Prof. R. D. Wilson: The Radical Criticism of the Psalter.
- SURVEYORS' INSTITUTION (Annual General Meeting), at 5.
- ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—T. Hastings: Devonshire House Buildings.
- ROYAL GEOGRAPHICAL SOCIETY (at Aeolian Hall), at 8.30.—W. F. P. Burton: Central Katanga.

TUESDAY, MAY 31.

- ROYAL SOCIETY OF ARTS (Dominion and Colonial Meeting), at 4.30.—Dr. T. Baldasano: Spanish Morocco.
- ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. A. Bierman: (a) The Development of Chloro-Bromide Papers; (b) The Exposure of Colour-Screen Plates.

WEDNESDAY, JUNE 1.

- ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.—Sir James Berry, G. Turner, and others: Discussion on The Treatment of Cleft Palate by Operation.
- ROYAL MICROSCOPICAL SOCIETY, 7.30 to 10.—Annual Pond Life and General Microscopical Exhibition.
- ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Dr. H. Scott: Narrative of an Entomological Expedition in Central Abyssinia.

THURSDAY, JUNE 2.

- GENETICAL SOCIETY (Annual General Meeting) (at Linnean Society), at 8.—Dr. R. A. Fisher: Light and Dark Lines in Pied Mice.—C. Diver: The Problem of Natural Selection in Relation to *Helix* (Cepaea).—Prof. R. B. Gates and Miss M. L. Sheffield: On Meiotic Arrangements in *Oenothera* and their Bearing on Segregation.—W. C. F. Newton: Sex in *Silene Otites* Agg.
- ROYAL SOCIETY, at 4.30.—Prof. S. Chapman and A. E. Ludlam: A Theoretical Discussion of certain Elastic Constants of Calcite and Crystalline Sodium Nitrate.—R. W. Fenning and H. T. Tizard: The Dissociation of Carbon Dioxide at High Temperatures.—L. H. Callendar: The Influence of Boundary Films on Corrosive Action.—To be read in title only.—N. R. Sen: On Fresnel's Convection Coefficient in General Relativity.—C. F. Elam: Tensile Tests on Alloy Crystals.—A. J. Bradley and J. Thewlis: The Crystal Structure of a Manganese.
- CHEMICAL SOCIETY, at 8.—U. R. Evans: The Passivity of Metals. Part I. The Isolation of the Protective Film.—Prof. T. M. Lowry and R. R. Goldstein: Studies of Valency. Part VIII. The Molecular Structure of Vernon's Dimethyltellurium Salts.—E. Roberts and E. E. Turner: The Factors Controlling the Formation of Some Derivatives of Quinoline, and a New Aspect on the Problem of Substitution in the Quinoline Series.
- INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).

FRIDAY, JUNE 3.

- PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. E. H. Rayner: The Forthcoming Eclipse of the Sun (Lecture).
- ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. G. M. Trevelyan: Carlyle as an Historian.
- ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Dr. G. W. C. Kaye: X-rays, and some of their Uses.
- INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).

SATURDAY, JUNE 4.

- INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).
- INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at Maidstone).

PUBLIC LECTURES.

SUNDAY, MAY 29.

- GUILDHOUSE (Eccleston Square, S.W.), at 8.30.—Prof. J. Garstang: Recent Discoveries in Palestine.

TUESDAY, MAY 31.

- CHELSEA PHYSIC GARDEN (Swan Walk, Chelsea Embankment), at 5.—B. Gerritzen: The Growing, Marketing, and Exporting of Fruit and Vegetables in the Netherlands (Oadwick Lecture).

THURSDAY, JUNE 2.

- INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Prof. C. A. Lovatt Evans: The Alkalinity of the Blood.

CONVENTIONS.

JUNE 6 TO 9.

- CONVENTION OF CANADIAN CHEMISTS (at Quebec).

JUNE 6 TO 11.

- PHOTOGRAPHIC CONVENTION OF THE UNITED KINGDOM (at Warwick).
- Monday, June 6.—Afternoon.—Welcome by the Mayor of Warwick. Installation of President. Presidential Address. Annual General Meeting.
- Tuesday, June 7.—Evening.—H. Baker: Lecture.
- Wednesday, June 8.
- Thursday, June 9.—Evening.—A. S. Newman: Lecture.
- Friday, June 10.—Evening.—A. Keighley: Lecture.
- Saturday, June 11.



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British Chemical Abstracts.¹

THE appearance of the first index volume, covering the whole of the abstracts in pure and applied chemistry issued during 1926 under the direction of the Bureau of Chemical Abstracts, is a notable achievement. Marking, as it does, the completion of the first period in what promises to be a valuable co-operative and unifying enterprise, it represents a definite British contribution to the armoury of chemical knowledge and research. So far as the fields of physical, inorganic and organic chemistry, biochemistry, and chemical technology are concerned, few investigations of real importance, few new facts or measurements, few patents of chemical processes, can have failed to be reported in the abstracts on which this index is based. Since the rate of advance in any branch of knowledge so largely depends on an adequate acquaintance with the experimental results and theoretical views which form the starting-point of any new research, the efficiency of the abstracting and indexing service is a matter which closely concerns every investigator, teacher, and student.

Since 1871 the Chemical Society has undertaken, on a systematic and extensive scale, the preparation and publication of abstracts of papers in pure physical, inorganic, organic, analytical, mineralogical, and biological chemistry; besides the annual indexes, collective indexes have been issued covering the periods 1841-72, 1873-82, 1883-92, 1893-1902, 1903-12, and 1913-22. The Society of Chemical Industry has similarly surveyed applied chemistry since 1882, and has published collective indexes for the periods 1882-1895 and 1896-1905.

Naturally, a considerable amount of material appeared in both publications, and from time to time tentative efforts were made in the direction of collaboration. Real co-ordination, however, was initiated only in 1924, when the Bureau of Chemical Abstracts, composed of four representatives from each of the two societies, was constituted with the object of securing, so far as might be possible, unification of the two sets of abstracts. Ever since the Bureau was established, Prof. J. C. Philip has acted as independent chairman, and the new organisation has also had the advantage of the advice, in an honorary capacity, of Mr. A. J. Greenaway, formerly editor of the *Journal of the Chemical Society*. The regular staff of the Bureau consists of an editor, Mr. T. F. Burton, supported

¹ British Chemical Abstracts issued by the Bureau of Chemical Abstracts. Index, 1926. Pp. 430. (London: Society of Chemical Industry.)

by eight specialist assistant editors, each in charge of an appropriate branch, and a large staff of abstractors, as well as an expert indexer. The publication as a whole, composed of two sections dealing with abstracts in pure and applied chemistry, is now known as "British Chemical Abstracts"—A and B, respectively.

At the outset, the possibility of co-operation with the American Chemical Society with the object of producing one chemical abstract publication in the English language was thoroughly explored, but progress in this direction proved to be impracticable. The Bureau then proceeded, with what patience and persuasiveness one can only surmise, to secure consent to a common format for the two sections of the abstracts, and a joint index. Thanks to the Chemical Society's action in giving up its well-known octavo format, agreement was reached in 1925 and the new scheme was initiated in January 1926. From that date onwards both A and B abstracts have been published—the former monthly, the latter fortnightly—in double column quarto, the overlap has been eliminated, and the A abstracts (pure chemistry) rearranged and paginated continuously, whilst the type and set up of the B abstracts (applied chemistry) have been brought into conformity with the A section. The first year of this new arrangement has now been completed by the publication of the index part, consisting of 430 pages. It has been necessary to adjust differences in the two systems of indexing previously employed, and to deal with some 50,000 index cards, so that the Bureau may be excused if the publication, which is to serve as a model, appears later than was hoped.

The index *qua* index requires little comment. It is based on the nomenclature and arrangement adopted by the Chemical Society; it includes a list of patents and a list of the journals abstracted; but not, unfortunately, a formula index, that expensive luxury.

In two respects, perhaps, the service offered to the chemist by "British Chemical Abstracts" is such as to merit his special attention. In the first place, it offers him abstracts which are admittedly second to none in accuracy; it is the policy of the Bureau that, so far as is practicable, the abstracts shall be prepared by abstractors and examined by editors who have specialised knowledge of the subject concerned. The degree of detail permitted in the abstracts depends to some extent on the accessibility of the original publication to British chemists, but every new substance is specifically mentioned. In the second place, promptness in

the publication of abstracts is regarded as being of primary importance, and "British Chemical Abstracts," when compared with other similar publications, proves to have an excellent record in this matter.

According to the list at the end of the index, some 400 journals come directly or indirectly under the review of the Bureau's staff. It is of course financially impossible at present to spread the net so wide as does the corresponding American publication; moreover, it is doubtful whether much advantage would accrue from the inclusion of a large amount of ephemeral, borderline, and even non-chemical matter. A systematic survey of all possible sources of information is, however, made, and certainly there can be very little valuable information that escapes the attention of the Bureau and its staff. Much of the so-called borderline material is of course abstracted by other bodies—scientific and trade societies and research associations—the scope of which, although sufficient for their own purposes, is admittedly incomplete. It might conceivably be possible to secure some measure of effective co-ordination or co-operation between the Bureau and such organisations as would result in financial advantage as well as economy of effort on the part of the user. The Bureau would no doubt welcome constructive criticism, and give the most careful consideration to any suggestions calculated to enhance the value of its publications.

The Peoples of Sarawak.

Natural Man: a Record from Borneo. By Dr. Charles Hose. With a Preface by Prof. G. Elliot Smith. Pp. xvi + 284 + 60 plates. (London: Macmillan and Co., Ltd., 1926.) 30s. net.

THOSE who desire to gain some knowledge about the attractive inhabitants of Sarawak will find what they require in this interesting and informative book by Dr. Hose. All the information here given about the natives, and much besides, will be found in the "Pagan Tribes of Borneo," by Dr. C. Hose and Dr. W. McDougall. The serious student cannot afford to neglect the older work, but sufficient material will be found in the new book to satisfy most other readers. Owing to his long residence in the country, his intimate and sympathetic knowledge of most of the tribes, and his friendship with many individuals, Dr. Hose not only writes with authority, but also is able to handle his multitudinous facts with ease and to bring out the essential points of material

and social culture, besides giving a good insight into the mental and moral characteristics of the more important peoples. The value of the book is enhanced by the very numerous and beautiful photographs, which were mostly taken by the author and do really illustrate the text. A certain number, including two of the four coloured plates, appeared in the older work, but many are new and all are appropriate. There is a useful map of tribal distributions.

Dr. Hose deals at the beginning with Borneo when it was inhabited solely by hunters and collectors of jungle produce. Then cultivation (more particularly of rice), metal-working, the building of long-houses, and many other cultural elements were introduced; most of the aboriginal population assimilated these to a greater or lesser extent, and this congeries of tribes has been named the Klem-antans by Dr. Hose. Certain groups, however, persisted in the old way of life; these are the Punan and allied wanderers in the jungle. Later migrations of people with a similar culture, but more highly organised socially and possessing greater physical and mental virility, were those of

the Kayan-Kenyah peoples, whose cultural affinities with tribes in northern Burma and in Assam have often been noted. These are the most advanced of the true Borneans, and it is with them that the book mostly deals; they appear to have entered Borneo from the south. The north was affected by the invasion of the Murut, who, Dr. Hose thinks, came from the Philippines or from Annam. They were not a water folk, and are supposed to have introduced terrace cultivation, the buffalo, and various distinctive weapons and customs; they do not use the blow-pipe. The last migration, which is estimated to have occurred less than 300 years ago, was that of the Iban, or 'Wanderers' (the so-called Sea-Dayaks), who under Malay leadership raided the north-west and penetrated

up numerous rivers, a turbulent crowd glorying in head-hunting. There appears, however, to have been an earlier immigration of the same stock, but of gentle manners and more settled habit.

The great resources of Borneo attracted the Chinese more than a thousand years ago, and at intervals they claimed a partial suzerainty. Before the Mohammedan Malays became dominant in Brunei it was a Bisayan kingdom under Buddhist sovereigns. Indo-Javanese influence made itself felt, more especially in the west, of which traces still persist. Pigafetta in 1521 was the first European to visit Borneo, and various abortive attempts to settle in the island were made by



FIG. 1.—Iban women dancing with the heads of enemies at a festival. (From "Natural Man.")

Europeans in the seventeenth century. The Dutch eventually established themselves in the south, and in 1839 the brilliant and adventurous James Brooke arrived on the north coast and shortly afterwards became Rajah of Sarawak. He instituted a policy of administration than which nothing could be better for the local conditions; this has been successfully followed by Rajah Sir Charles Brooke and the present Rajah, Sir Charles Vyner Brooke. The policy has always been to interfere as little as possible with native custom and belief, but necessarily life and property had to be made secure. As an example of the care for the people, it may be noted that many years before the rubber boom of 1910-11, Para rubber seeds had been imported and the natives were encouraged

to plant rubber for their own profit. The Rajah caused notices to be published that the natives were at full liberty to appropriate forest lands for this purpose, which would remain their property so long as they took care of the trees and worked the rubber properly. He also ordered that no sales of rubber plantations should be effected without the approval of the Government, and thus prevented exploitation by outsiders.

The administration of subject races, more particularly those in Africa, is a topic which is now being widely discussed. The method adopted in Papua has proved most excellent for peoples of very backward culture, and that employed in Sarawak is as admirable for somewhat more advanced peoples.

A. C. HADDON.

The Chemistry of Plant Activities.

Photosynthesis. By H. A. Spoechr. (American Chemical Society Monograph Series, No. 29.) Pp. 393. (New York: The Chemical Catalog Co., Inc., 1926.) 6.50 dollars.

ALTHOUGH not actively engaged as a teacher, the author has done a considerable service to education in writing a book on photosynthesis as he understands it. The educational value of this book, however, lies not only in the actual information it gives on what may be called the more descriptive physiological aspects of the phenomenon, but also on the broadness of outlook displayed in the treatment of the whole subject. With commendable thoroughness the author has put a very liberal interpretation upon the word 'photosynthesis,' and has drawn into his purview a number of aspects which might perhaps scarcely have been expected to have received the careful consideration which he has given them. Thus the cosmic and economic aspects of the problem are dealt with at considerable length, and are amplified and illustrated by numerical data which contribute materially to a proper appreciation of their significance; likewise the purely chemical and physical aspects are dealt with in a very lucid and thorough manner. It is by adopting this very comprehensive attitude towards the subject that the author points the way to future progress, for the reader will realise that many gaps in our knowledge of chemistry and physics need to be filled before there can be much hope of a better understanding of the process of assimilation of carbon by green plants.

The book is divided into seven chapters which are, in effect, complete monographs of the various

aspects of the question with which they deal, being supplied with continual references to original literature. From the point of view of the teacher or the advanced student, this is altogether excellent, since the book may be confidently relied upon to present a complete account of our present knowledge of the subject concerned. To the less experienced student this wealth of information may perhaps be a little embarrassing, more particularly as the author has an occasional tendency to break away from a subject and to return to it again later, which makes it necessary for the student to connect the various pieces together before he can get the continuous story.

The opening chapter, entitled "The Origin of Organic Matter and the Cosmical Function of Green Plants," is one of particular interest. There is probably no other book in which such a complete account of this aspect of the subject is to be found; the author has here collected together a mass of data with regard to solar radiation and the disposal by the leaf of the solar energy incident upon it, and illustrates it graphically in a very convincing manner. Here also will be found a comprehensive discussion of the solubility of carbon dioxide in fresh and sea water and its significance to aquatic plants, as well as a discussion of the economic aspects of the utilisation of the solar energy stored by the products of photosynthesis. Many of the data furnished in this very interesting chapter are culled from American sources which, though possibly easily accessible, are not familiar to the average reader.

The second chapter deals with "The Nature of Photosynthesis as Determined by Observations of Gas Interchange and the Formation of Organic Matter." This is by far the longest chapter in the book, and is the one which will appeal more particularly to the plant physiologist. Describing first the path of the gaseous interchange at the surface of the leaf and the work of Brown and Escombe, the author passes on to a consideration of the carbon dioxide content of the soil atmosphere and of natural waters. After carefully distinguishing between the terms 'photosynthetic' and 'respiratory quotient,' he introduces the principle of limiting factors. In discussing the effect of light he wisely administers a much-needed warning to those who may still be in need of it—and, sad to say, there are still a good many—in the following words: "... there is no sense in considering the photosynthetic activity in different coloured light without at the same time determining the energy relations of the light employed."

Attention is also directed to the fact that "the method of measuring the rate of photosynthesis by the appearance of starch in the leaf cannot be considered as being very accurate," since the formation of starch is itself not dependent upon the presence of light. He also administers the *coup de grâce* to one other much-cherished idea by the statement that "there is apparently no relation between photosynthetic efficiency and the absorption bands of chlorophyll." After dealing successively with each of the various limiting factors in detail, the chapter is brought to a close with an account of the more recent work of Plaetzer, Harder, and Warburg on the 'compensation point,' that is to say, the light intensity at which the respiratory and photosynthetic activities compensate each other.

In Chapter iii., entitled "The Products of Photosynthesis," the author gives a fairly exhaustive description of the occurrence and character of such carbohydrates as are found in the leaf, and may therefore be regarded as being, at any rate potentially, primary products of photosynthesis, and on these grounds excludes from this description such substances as trehalose, raffinose, melicitose, etc. Here also will be found a good summary of the vexed question of what is the first product of photosynthesis. The succeeding chapter gives a very clear account of the methods of measuring photosynthetic activity.

In Chapter v. the author sets forth in characteristically thorough manner the various hypotheses regarding the steps in photosynthesis. He says of Baeyer's theory that "it is a good suggestion of a possible mechanism of photosynthesis," but of recent work purporting to support the formaldehyde theory he says: "Condensing formaldehyde with strong alkalis or through the action of ultra-violet light and obtaining a great mixture of substances of which only a small per cent is in many cases hexose sugar, will, even to the most optimistic chemist, appear as a rather far cry to the method by means of which the plant forms glucose."

Chapter vi., on the energy relations in photosynthesis, contains a valuable summary of all the more recent work on this difficult subject, while Chapter vii. gives a fairly detailed but well-summarised account of the methods of isolating the various leaf pigments, including the separation of chlorophyll - *a* and - *b*; there is also a section devoted to the chloroplast.

There is a considerable number of misprints, more particularly of plant names, one of the most

peculiar distortions being that of *Heleodea* for *Elodea* on p. 85. The book provides, however, most interesting and inspiring reading; it is impartially critical, and frequently indicates the direction in which further work is desirable. The author has produced a work for which teachers both of plant physiology and of chemistry should be very grateful.

The Future of Magnetism.

Magnetism and Atomic Structure. By Dr. Edmund C. Stoner. Pp. xiii + 371. (London: Methuen and Co., Ltd., 1926.) 18s. net.

IT is probably recognised by every one that the main interest in physics of to-day lies in the study of the atom. Much of the information with regard to the atom has been obtained by studying spectra; chemistry, magnetism, X-ray scattering, etc., play only a subsidiary part. We must admit, however, that our spectroscopic material is now more or less exhausted, and that we must look for fresh sources of information.

Much may be said in support of the opinion that magnetism will open a new way by which to approach the study of the structure of the atom. The atom is essentially an electromagnetic system which consists of a positively charged nucleus with negative electrons revolving round it. If the atomic number of the atom is given with its nuclear charge, and if the electrons arrange themselves round the nucleus in a definite way, then this arrangement of the electrons practically fixes all physical and chemical properties of the given element.

The magnetic field is probably the only practical weapon by means of which we may hope to change the motion and arrangement of the electrons in the atom, and thus influence all the physical and chemical properties of the atom. In only a very few cases at the present time do we find that the influence of the magnetic field on the properties of the atom is noticed. This is because the influence of the available fields is too weak to produce a marked change in the properties of the atom, and our present methods of magnetic research are not sufficiently refined to study them. The most easily observed magnetic phenomenon is the Zeeman effect, and this has a tremendous influence on the present theory of the structure of the atom.

It is possible that the difficulty of experimenting in magnetism, and the small amount of trustworthy experimental work done, account for the fact that magnetism has been somewhat neglected. During

the last few years, however, a considerable amount of research has taken place, and new methods of approaching the subject have been developed, and we now have to recognise a marked advance in magnetism.

It is on this account that we have to welcome Dr. Stoner's book, especially as it attempts to give an account of our present knowledge of theoretical and experimental magnetism from the point of view of its relation to the structure of the atom.

The task of writing such a book, the counterpart of which has not before been published in any language, is indeed difficult; and in his preface Dr. Stoner himself admits the difficulty. The material which an author of a book on magnetism has at his disposal is very large, but the great amount of contradiction in experimental as well as in theoretical work makes the problem of selection very considerable.

In his preface Dr. Stoner states, "Prominence is given to the work which is thought to be of most important and lasting value," and the difficulty of selection may be illustrated by the following example. In Chapter xii. (p. 273, para. 4), Glaser's experiments are described at length, and in Chapter xv. they are well discussed. A few weeks before Dr. Stoner's book appeared, however, Glaser's experiments were repeated by Lehrer by a more refined method (*Z. für P.*, vol. 37), and it was shown that the increase of atomic diamagnetic susceptibility at low pressures in diamagnetic gases, as observed by Glaser, is almost certainly due to experimental error. This example is given, not to criticise Dr. Stoner's work, but simply to illustrate the difficulty of his undertaking.

On the whole, we must agree with Dr. Stoner's choice and with the manner in which he has put together the material at his disposal. The experimental and theoretical parts of the book are well divided; it is free from heavy mathematics; the subject is well brought up-to-date, and the references which follow each chapter are very valuable.

Dr. Stoner also gives a brief account of electrodynamics, the quantum theory, and other work which has been done on the structure of the atom, so as to enable the unprepared reader to follow the main subject of the book. We scarcely consider that such a brief account is sufficient to impart the preliminary knowledge necessary to follow the subject of the book—it can be regarded only as a means of recalling certain facts with regard to electrodynamics and the quantum theory to the mind of the reader who is already acquainted

with them. It is doubtful whether it is really advisable to include this account in the book.

In general, the book is of more use to the experimentalist than to the theoretical research student. A close study of it reveals one or two slips and misunderstandings, but none of a very serious nature. Attention may be directed to one of these, and that is on p. 196, where Dr. Stoner makes some calculations on the gyro-magnetic effect. In this connexion the equations (9.2) are wrong, as the author puts the sign of equality between two expressions which cannot be equal. On the following page he himself suggests that this may be 'wholly wrong,' and so it is.

It is probable that as magnetism attracts more and more attention, and as its importance in the study of the atom increases, we shall soon have more books published on this subject. Dr. Stoner's book is, however, the first on this subject, and we welcome it as a very good commencement and as an important contribution to our present literature on magnetism.

P. KAPITZA.

The Educational Ladder.

Social Progress and Educational Waste: being a Study of the 'Free-Place' and Scholarship System. By Kenneth Lindsay. Pp. vii + 215. (Studies in Economics and Political Science, No. 88.) (London: George Routledge and Sons, Ltd., 1926.) 7s. 6d. net.

MR. KENNETH LINDSAY, who was Labour candidate at a recent parliamentary election in Oxford, has written a very instructive study of the adequacy of the provision made for scholars to pass upwards from the elementary school to higher places of education, and the use made of it. He quotes with justifiable scepticism Lord Birkenhead's recent dictum that "the number of scholarships from the elementary to the secondary school is not limited, awards being made to all children who show capacity to profit"; and examines the actual facts carefully in four or five selected districts—London, Oxfordshire, Warrington, Wallasey, with a shorter account of Bradford.

The book is an interesting illustration of the fact that, however small and technical the point of departure may be, if the argument is pursued faithfully, a survey of all the connected fields is gained. This is especially true of sociology, and Mr. Kenneth Lindsay, by his thoroughness and acuteness, manages to give us a fairly complete sociological picture of London and some of the other places simply by following the record of the

scholars proceeding from the elementary to the secondary schools in the area.

The main conclusions may be very briefly summarised. The ladder of which Lord Birkenhead spoke affects at most 20 per cent. of the elementary school population; 80 per cent. go no further in their scholastic education. It also appears quite clearly that the minority who do pass on are mainly from the lower middle class of clerks and small traders, and that their children by their continued education are enabled to remain or rise a little higher in the same class. Individual cases are mentioned of the sons of manual workers who become professors or civil servants, but it is abundantly proved that the mass of the workers are untouched by the secondary system. The root of the difficulty is poverty. Even if more secondary and central schools were provided, the need of the parents for their children's earnings would prevent any large number taking advantage of them.

To Mr. Kenneth Lindsay this fact points to a much more generous subvention from the State towards the maintenance of scholars: he indicates his own belief in an all-round allowance to parents. From the educational point of view the book will incline most of us to the solution just advocated in the Report of the Consultative Committee on Adolescent Education, namely, the gradual raising of the universal school age to fifteen years as economic conditions permit, that is, concentrating more on the improvement of the education of all than on a large immediate increase either in secondary schools or in scholarships. F. S. M.

Our Bookshelf.

The Work of the Royal Engineers in the European War, 1914-1918. Compiled by Col. G. H. Addison. Published by the Secretary, Institution of Royal Engineers, Chatham. Miscellaneous. Pp. iii+372+100 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1927.) 20s.

THIS volume, the last of the series prepared by Col. Addison to illustrate the manifold activities of the corps of Royal Engineers during the recent European War, covers a wide range of activities. It shows in what manner the corps rose from 1569 officers and 23,521 other ranks (including Territorials) in August 1914 to 11,830 officers and 225,540 other ranks in August 1918. The mere list of units included in 1918 shows what the developments in warfare had brought under the control of the corps: water boring, sound ranging, tunnelling, gas and anti-gas methods, meteorology, land drainage, forestry, laundry, cinema and camouflage were amongst the many which the engineer-in-chief had to organise and supply with stores.

The subject of most general interest in this volume is the account of the camouflage service. Once again we see the shattered tree near Burnt Farm, and we learn that Colonel Solomon drew its bark from the King's Park at Windsor. It is not without some amusement that we note that for purposes of R.E. the artists in the Camouflage section were rated as painters and the sculptors as plasterers. From the chapter on the organisation of engineer intelligence and information emerges the somewhat startling fact that none of the maps supplied to the Army by the French staff recorded the existence of the unfinished Canal du Nord.

The chapters on concrete defences, on forward communications (duckboard tracks, decauville, mule tracks, plank roads, etc.) and on machinery, workshops (with the wonderful list of articles manufactured by the R.E. during the War), and electricity have their own special interest and might serve as a very useful text-book for engineers engaged in pioneer work in the outposts of civilisation. The concluding chapters on searchlights, inundations (our own and the enemy's), and training schools help further to illustrate the magnitude of the whole task of organising the engineering services required in the War and the success with which the task was accomplished.

Practical Organic and Bio-Chemistry. By Prof. R. H. A. Plimmer. New edition. Pp. x+568. (London: Longmans, Green and Co., Ltd., 1926.) 21s. net.

THE need for a new (the third) edition of this book is in itself an indication of the appreciation of the public to which it is addressed. The author in revising his work, in addition to making numerous changes of detail, has again to some extent modified its scope. The book has been made more theoretical and less practical and at the same time more elementary.

We greatly regret this decision on the part of the author. Instead of developing into a valuable aid to laboratory practice in general biochemistry, the book is gradually becoming unequal in its treatment of various branches of the subject and overweighted with theoretical matter, much of which is too condensed (e.g. the anthoxanthins, the terpenes, and the alkaloids) to be of value for the class of students for which the main bulk of the book is intended.

Considered as a text-book for medical students, however, the book preserves the qualities which it has always possessed, and the sections on proteins, colloids, and digestion may all be cited as characteristic examples of the mode of treatment.

If, however, its virtues have been retained, so have some of its vices. The author still omits all reference to hydrogen ion concentration, its determination and its influence on biochemical phenomena. This constitutes a very serious, and in our opinion inexcusable, defect from which the book suffers throughout. The student, medical or other, who relies upon this work will find himself in this respect deprived not only of a general point of view of the greatest utility, but also of much

valuable information, and will be greatly hampered if he should attempt to enlarge his ideas by reading current biochemical literature.

A large amount of new information has been incorporated into the text; thus glutathione, thyroxine *à la* Harington, and the irradiation of cholesterol are all included. On the other hand, oxidation-reduction potentials and the bacterial production of acetone and butyl alcohol from starch seem not to be mentioned. A. H.

Home Fires without Smoke: a Handbook on the Prevention of Domestic Smoke. Edited by Cyril Elliott and Marion FitzGerald. Pp. xvi+59. (London: Ernest Benn, Ltd., 1926.) 3s. 6d. net.

THIS small book is of the popular type setting forth in simple language the existing methods available for preventing domestic smoke. There is a useful foreword by Sir Napier Shaw, and four chapters by different authors. Solid fuels are dealt with by Dr. M. Fishenden, gas by Mr. F. W. Goodenough, electricity by Major F. H. Masters, and the general housewife's problem by Miss Bushell and Miss Gordon. The book should help those desirous of knowing what they can do to eliminate domestic smoke.

Dr. Fishenden is a strong advocate of coke as a fuel for continuous use. Mr. Goodenough gives a very clear review of the possibilities of gas. He directs attention to a point not sufficiently realised when comparing the cost of gas for domestic use with that of solid fuel, that is, the saving of the time of the housewife. The case for electric heating and cooking is naturally supported strongly by Major Masters; he makes a good deal of the efficiency with which electricity is converted into heat and utilised, but no stress is laid on the necessity first to convert coal into electricity, with a heavy loss in the process. In his foreword, Sir Napier Shaw emphasises the scale of the smoke problem, a point often forgotten. Referring to the possibility of substituting gas and soft coke for the large amount of coal burned each year in domestic fires, he directs attention to the problem of disposing of the gas if sufficient coal were treated.

It is stated by Mr. Goodenough (p. 18) that gas "is probably available to something like 95 % of the population of these islands," and, on the same page, that "some forty million tons of coal are still burned in British dwelling-houses every year." These two statements taken together show that the disposal of the gas would be a real difficulty.

The book is not provided with an index, although a fairly complete list of contents is given.

J. S. OWENS.

Les physiciens hollandais et la méthode expérimentale en France au XVIII^e siècle. Par Prof. Pierre Brunet. Pp. ii+153. (Paris: Albert Blanchard, 1926.) 14 francs.

THE legacy of Newton and his contemporaries of the seventeenth century has often been described. This was the century, too, that saw science organised through its societies on rational lines that

at the same time made possible international relationship and collaboration on a scale hitherto impossible. The excellent volume before us deals with the handling of this legacy by the continental physicists of the eighteenth century. It is perhaps insufficiently realised that international relationship has affected the progress of science almost as often as it has the progress of peoples; and the historian of science who is concerned with the development of the broader aspects of his subject is confronted with continual illustrations of this. The French Descartes lived his scientific life in Holland; Huyghens was a Dutch philosopher who worked in France and visited England; 'S Grave-sande, of Leyden, was a member of the delegation of 1715 sent to England to congratulate George I. on his accession. Desaguliers was a Dutch philosopher who was educated in England. Here are but a few of the ingredients of international relationships in science. The eighteenth century was notable for the rise of the Dutch experimental school of physicists, and the story of the development of the experimental method in Holland, and of its influence on the mathematical methods of the French school, is dealt with by Prof. Brunet with a sympathy, a penetration, and an understanding that has resulted in a volume of unique value to all students of the history of science.

I. B. H.

Mongrel Virginians: The Win Tribe. By A. H. Estabrook and I. E. McDougale. Pp. 205+2 plates. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 13s. 6d. net.

THIS study of a group of Indian-white-negro crosses is a sociological and eugenic study of a group which has lived in the same locality in Virginia for more than a hundred years. It originated from a white-Indian union, with later introductions of 'mean-white' and negro strains. The group consists of about five hundred individuals in an area approximately eight miles long by four miles broad. They are mostly living on the land. The original white family, judging from its social and economic position, was probably above the average. The descendants are almost without exception below the low white in average ability.

One hundred and forty-five pages of the book are taken up with a history of the individuals so far as it has been possible to recover it, and this is followed by certain deductions from the data as to fecundity, consanguinity, legitimacy, and the like. As a sociological record this material has value; but as a scientific study it leaves much to be desired. The fact that a large number of the females have been prostitutes, and that white men from outside have resorted, and continue to resort, to the area, introduces an element of uncertainty into the data. Further, it is to be regretted that advantage has not been taken of such a promising opportunity to examine on anthropological and genetic lines such exceptional material for the study of a number of problems relating to heredity, inter-breeding, and racial crossing.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Transmutation of Elements.

PROF. A. SMITS, in a letter in NATURE of Jan. 2, 1926, announced the possibility of transmuting lead into thallium and mercury. In the December number of *Zeits. f. Elektrochem.* these experiments are described in more detail by Smits and Karssen. They used a quartz tube, furnished with two steel electrodes with carbon points, which dip down into the liquid lead. The amount of lead used is about 900 grams, which is kept liquid in a side tube all the time. When an experiment is performed, the tube is tipped and the lead is brought over into the main tube. The arc which is burning between two inner surfaces of lead is either continuous or intermittent, the main consideration being to obtain as high a current density as possible. The first method gave strong spectroscopic evidence of mercury and thallium after 10 hours' burning at ± 35 amp. The second is the so-called sparking method, in which a current of 60-100 amp. can pass through the tube at the make of the arc, that is, when the tube is short-circuited through the liquid lead. Here all the mercury lines, even the very weak ones, were present after $9\frac{1}{2}$ hours' sparking.

I have been trying to check this work of Smits and Karssen, using a tube of similar construction, the dimensions, however, being smaller, as the amount of lead used was only 180-200 gm., and the bore of the tube where the arc was burning was $\frac{3}{8}$ in. The sparking method was first tried with an evacuated tube for 14 hours, with a current in the short-circuited tube of 60-75 amp., plus $21\frac{1}{2}$ hours with 80-90 amp. The lead was found to be pure by spectroscopic examination before the run started, and the spectra throughout the experiment, mostly photographed at 5-hour intervals, showed no mercury or thallium lines.

After a breakdown of this tube, a new run was started with new lead which, however, on very good spectrograms, showed slight traces of mercury and thallium. This time the arc was burning in $\frac{1}{2}$ - $\frac{3}{4}$ of an atmosphere of nitrogen. First, an experiment with continuous current was performed for 25 hours, with current densities from 15 amp. to 25 amp., the latter value being maintained for 10 hours at about 38 volts. No appreciable change in the intensity of the mercury and thallium lines could be detected. The sparking method was again tried with nitrogen filling, without changing the construction of the tube or touching the lead. No mechanical devices were necessary, since the arc under a certain pressure and with a certain amount of lead present, will make and break itself as soon as the lead surfaces are brought to contact. This way of sparking should be very effective, as the arc runs through all stages of burning. After a 10 hours' run with 65 amp. to 95 amp. was performed, the scheme of connexions was changed, putting a condenser across the terminals, and a big inductance in series with the tube to protect the generator against transients. The current in the arc was now increased to 120 amp. short-circuited, and was about 60 amp. when the arc broke. With this arrangement a 12 hours' run was performed, but no increase in the strength of the mercury or thallium lines could be detected. The actual burning time of arc was a little less than half the time, and the number of contacts ranged around one a second. On increasing the

current up to 150 amp., the tube broke after $2\frac{1}{2}$ hours' run.

As will be seen, the currents compare with, and even exceed, those used by Smits and Karssen, and as the dimensions of the tube are smaller the actual current densities are higher. On account of the smaller amounts of lead used, the expected products of transmutation should be more easily detected, but in spite of these two favourable conditions no transmutation could be found.

It is the author's intention also to try out the second method by which Smits and Karssen claim to get positive results, namely, high potential discharges between lead electrodes in carbon disulphide.

L. THOMASSEN.

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The Floods at Memphis.

THE news of the dangerous floods at Memphis, Tennessee, inevitably invites a comparison with its Egyptian namesake. The modern town was laid out in 1819 (soon after the evacuation of the surrounding territory by the Chickasaw Indians) by three men, John Overton, Andrew Jackson, and James Winchester, who gave it the name of the most ancient of the great capitals of Egypt because of the similarity in the geographical positions of the two sites. They realised that the American site enjoyed an advantageous position at the head of the navigable waters of the Mississippi, and from that they doubtless hoped—and time has amply justified their hope—to derive the great commercial future for their new city which a like position at the apex of the Nile Delta had secured for Egyptian Memphis throughout a period of three thousand years.

It seems possible, however, that the founders of the town had forgotten the implicit warning of Herodotus, who made his headquarters at Memphis when he visited Egypt in the latter half of the fifth century B.C. Speaking of the foundation of that city in the dim beginnings of Egyptian history, he tells us (as the priests had told him) how the river had originally flowed right under the western cliffs—as it might be the Chickasaw Bluffs in Tennessee—and how, in order to secure a larger area of low-lying irrigable land, the reigning king dammed the Nile and turned it into the middle of the valley between the two desert ranges, and then let it rejoin its bed at the apex of the Delta. He goes on to say that "to this day" (his day) the point at which the river was thus bent out of its old course was guarded by the Persians—then ruling Egypt—"with the greatest care," and was strengthened every year. "*For if the river were to burst out at this place, and pour over the mound (i.e. the dam), there would be danger of Memphis being completely overwhelmed by flood.*"

We have no exact information as to the nature of the defences thus so carefully manned by the Persians, though we may feel tolerably certain that they consisted simply in the earth banks which are almost as old in conception as the Nile mud itself and are still to be seen throughout the length of Egypt to-day. But the Greek historian's account has been verified and very happily supplemented by modern excavation. Herodotus tells us of a "camp of the Foreigners." Sir Flinders Petrie, who dug at Memphis for several years before the War, guessed that this referred to the mixed levies of the Persians; and in his first season's work he struck a building which, as he had calculated, turned out to be this very camp. It lay on the south-east edge of the

town, precisely where we should expect to find the "army of occupation" whose main business was to secure the city from flood. Memphis was at this time the commercial centre of Egypt as well as being its capital, and it was natural that the Persians should keep a strong armed force in this outpost of their empire. The size and heterogeneous nature of this force is attested by large numbers of small terracotta figures representing men of all nations, from the Scythians on the north-west to a Mongolian type coming from farther India, thus indicating the extreme limits of the Persian sway. The Egyptian, we know, was from the earliest times fond of caricature, and these figurines, though showing the influence of the Greek artists then fashionable in Egypt, are definitely the work of native craftsmen. An interesting feature is the absence of women among the foreign types, although Egyptian women occur fairly frequently. The explanation is clear enough. Memphis had become for a time the Cologne of Egypt—if one may be permitted the anachronism—and the army of occupation, consisting of units many of whom were thousands of miles from their native lands and who doubtless despaired of seeing their own homes again, followed the natural course and took wives from among the native women. That these should in their turn become a butt for the jesting hands of their fellow-countrymen is not surprising. Thus to the bald remarks of the ancient historian archæology has added such convincing details as these models of the very soldiers, whose 'foreign service' for a considerable period was the comparatively 'light fatigue' of patrolling and repairing the dams of Memphis.

Such a strict watch was still kept up at every Nile flood until a few years ago, when the irrigation works of the British engineers put the water under more perfect control, and thus practically removed the danger from flooding. Centuries of experience of the vagaries of the Nile floods, and perhaps a cautious instinct inherited from those earliest days of human occupation of the Nile valley, when every acre of cultivable land had to be won from Nature with great hardship and risk, must have made the Egyptians more than usually careful of their dykes. At all events it is interesting to note that throughout the five millennia of its history, during which we frequently hear of looting and partial destruction by conquering armies, there is no record, so far as I am aware, of the flooding of the town of Memphis. Yet its modern namesake, although advantageously situated on the hills forty feet above the river, and in spite of all the resources of modern science, is suffering this grievous calamity little more than a century after its foundation.

S. R. K. GLANVILLE.

Biological Fact and Theory.

TEMPTING though it is to deal with Prof. Huxley's personal references to myself and others, as they have no bearing upon the argument, I would return to my protest against his dogmatic statements about doubtful matters.

Among "the fundamentals of genetics to date" (NATURE, Mar. 5, p. 350) Prof. Huxley gives "the proof that the chromosomes carry the genes, and that the genes are arranged in linear order," and "the individuality of the chromosomes." The 'genes' are of course the factors of Mendelian heredity. I think I am right in saying that they are assumed to be small particles arranged in regular order in the chromosomes, each representing a particular character. Also it is apparently assumed that all characters are represented by genes.

Now the usual mode of distribution of the chromosomes between dividing cells before fertilisation, provides a perfect mechanism for the distribution of the 'genes' according to the 'Neo-Mendelian' theory, but this mode of distribution is not universal in connexion with fertilisation, as I have already pointed out (NATURE, Jan. 29, p. 161). The continuous individuality of the chromosomes from generation to generation of cells and whole organisms may be a fact in some cases, but is very doubtful in others. They appear only during the process of mitosis in most organisms. Several investigators of repute (e.g. Child, *Biol. Bull.*, vols. 12, 13, 1907; vol. 18, 1910; vol. 21, 1911) claim that amitosis occurs among the cells destined to produce gametes. Personally, I think there is some other explanation than amitosis for these appearances, but until this and the other points to which I have referred are demonstrated, the individuality of the chromosomes must remain as an attractive working hypothesis.

While in breeding experiments certain groups of characters do appear in the individuals of consecutive generations in the Mendelian manner, the great majority of characters are common to all the individuals of a race or even many races, and any such mechanism as is provided by the chromosomes for the distribution of Mendelian characters would prove an obstacle were these common characters represented by unit factors arranged in regular lines in the chromosomes. Moreover, certain breeding experiments suggest that similar characters (e.g. colour) may blend when races geographically widely separated are crossed, but segregate in the case of local variants (Prout and Bacot, *Proc. Roy. Soc., B*, vol. 81, 1909; *Entomologist's Record*, 15 and 16, 1906; *Trans. Entomol. Soc. Lond.*, 1906; *Proc.*, 1907). Blending of such important characters as the number of the vertebrae occurs in crosses between *Salmo salar*, *trutta* and *fario*. The progeny are fertile and there is apparently no segregation (Walker, "Hereditary Characters," 1910). "Very frequently, if not always, the character that has once been crossed has been affected by its opposite with which it was mated and whose place it has taken in the hybrid," and "Everywhere unit characters are changed by hybridism" (Davenport, "Inheritance in Poultry," p. 80, 1906). Many other instances might be cited.

The theory seems to me the most probable which requires least in the way of assumption. That recent variations are transmitted in the Mendelian manner; that they are always tending to blend more and more if they are preserved from generation to generation; and that racial characters, derived originally from individual variations, are produced through the general potentialities of the cell for development within definitely restricted limits, seems to me to require less in the way of assumption and to agree more easily with known facts than what is now put forward as the "Neo-Mendelian Chromosome Theory."

That the chromosomes are concerned in the transmission of the potentialities for developing Mendelian characters is an attractive and probably useful working hypothesis, and so long as Prof. Huxley and "the whole body of those engaged upon genetical research" treat this and the other hypotheses involved as useful "conceptions and theories" (as he now calls them, NATURE, April 30, p. 639) and not as 'laws' and proven facts, no one can complain.

"If therefore the Reader expects from me any infallible deductions, or certainty of *Axioms*, I am to say for myself, that these stronger Works of Wit and Imagination are above my weak Abilities. Wherever he finds that I have ventur'd at any small

Conjectures, at the causes of things I have observed, I beseech him to look upon them only as *doubtful Problems*, and *uncertain Ghesses*, and not as unquestionable Conclusions, or matters of unconfutable Science" (Robert Hooke, *Micrographia*, 1665 (Preface)).

CHARLES WALKER.

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Mav 4.

The Coat of Sheep.

THE letter under this title, by Prof. J. Cossar Ewart, in *NATURE* of Mar. 19, contains some observations so divergent from those we have made here that it seems desirable to contrast the two. He remarks: "From an investigation which has been in hand for some time on the structure of the fibre forming the coat of sheep, it has been ascertained that in sheep, as in man, the first coat consists entirely of simple pithless fine-wool fibres." In the course of investigations on South African sheep and wool, I have procured a fairly complete series of fetuses of the Merino, blackhead Persian, Afrikander, and Karakul, as well as of the Angora goat; and in each case microscopic sections have been made of the different stages in the development of the hair and wool. In view of the statement that "the first coat consists entirely of simple pithless fine-wool fibres," a re-examination has been made of all this material.

Prior to the extrusion of any fibres, apart from the coarse stiff ones over the lips, eyelids, and tip of tail, the appearance of the foetal skin in sections is much the same in all the types. The hair plugs vary much in depth within the dermis, and keratinisation first appears within the deeper and thicker follicles. Likewise the fibres from these are the first to reach the surface, and break through the outer cuticularised layer of the epidermis. For a short time after the extrusion only the tips are visible, and the degree of differentiation is so small that little distinction can be made between hair and wool. Later, when an external difference is apparent, the outer fibres are in every case the stronger and the inner are the finer. Moreover, in transverse sections of the skin the stronger fibres often reveal a medulla, while the fine fibres are solid. Fortunately, no uncertainty exists in the recognition of the medulla in sections, though its early stages are difficult in the extruded fibre. I have already shown (Duerden, J. E., and Ritchie, M. I. F., "Development of the Merino Wool Fibre," *S.A. Jour. Science*, vol. 21, 1924) that in the Merino it arises from the hair germ as a direct upward continuation of the basal layer of the epidermis, and its cells undergo keratinisation later than those of the cortex, cuticle, and inner root-sheath; stained in picro-carmin they are a brilliant red, surrounded by the clear yellow cortex.

On account of the evolutionary loss of most of the hairy fibres in such fine-woolled sheep as the Merino, and the feebleness of the medulla in those which remain, the distinction between hair and wool is not strongly marked. The blackhead fat-rumped Persian, now so plentifully farmed in South Africa for its superior mutton, however, has a covering altogether resembling that of wild sheep, namely, an outer hairy coat and an under woolly one; and it may therefore be taken as representative of the ancestral condition of all sheep. By the time differentiation of the fibres is established in the foetus the coarse, hairy, medullated fibres are found to project much beyond the fine wool, and there can be no question of the coarser fibres having appeared first.

The long stiff fibres of the lips and eyelids remain for the most part non-medullated until towards the close of foetal life when, with increasing diameter, a

pith develops; so that these fibres, the first to protrude, are truly hair, not wool. The morphological value of a fibre can scarcely be estimated before its growth is completed.

The results may be summarised as follows. The coarse medullated hair of the sheep and the fine non-medullated wool appear on the foetus at about the same time, the stronger fibres slightly in advance of the finer. In fine-woolled sheep the distinctions between the two sets of fibres are not pronounced in the early foetus, and the entire coat may have a semblance of wool; but towards the end of foetal life a medulla appears in the stronger fibres, thus marking them off as hair, and as representative of the ancestral outer hairy coat. In wild and coarse-woolled sheep the distinction between hair and wool is apparent much earlier, and the growth of the hair throughout is in advance of that of the wool.

J. E. DUERDEN.

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Chemical Formulæ of Mineral Compounds.

DURING the last decade I have accumulated some new facts which I believe are of fundamental significance. Certain theoretical considerations require that the chemical formulæ of *all* true mineral species composed of any of the first twenty-one elements of the periodic system should obey the following simple equation:

$$M = 2a + 8n,$$

where M is the molecular number (*i.e.* the total atomic number in the compound), a the number of atoms, excluding hydrogen, and n any integer.

My first notes, based on Dana's "Text-book of Mineralogy" (1912), recorded five exceptions to the above equation, disregarding four substances of organic origin. Later I verified that Dana (1922 edition) corrected the formulæ of aluminite and lazurite, leaving me with three exceptions only. Afterwards I obtained from other sources the corrected formula $(\text{Na}_2, \text{Ca})\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2 \cdot 10\text{H}_2\text{O}$ for faujasite and $\text{CaMg}_3(\text{SiO}_3)_4$ for tremolite, which left tavistockite as the sole exception for some time. Mellor's "Inorganic and Theoretical Chemistry" (1923) mentions the latter as $\text{Al}_2\text{Ca}_3(\text{OH})_6(\text{PO}_4)_2$, which is in perfect harmony with my equation. Granting the correctness of this formula, my list of exceptions is now reduced to merely four organic minerals—whewellite, oxammite, mellite, and fichtelite. These, however, were expected and bear a theoretical significance which cannot be discussed here. I have been able to cover most of the remaining minerals by a modification of the above equation based on a new theory, the satisfactory completion of which involves difficulties which I hope to overcome.

L. W. TIBYRIÇÁ.

Caixa 1330,
São Paulo, Brazil,
Mar. 25.

MR. TIBYRIÇÁ's formula, which amounts to the statement that $M - 2a$ is divisible by 8, may be interpreted in the following manner. Every atomic number of the elements from 2 (helium) to 21 (scandium) may be represented by the expression $2 + 8d + v$, where d is an integer from 0 to 2 and v an integer from 0 to 4, equal to the valency of the element. This is supposed to be due to the arrangement of the electrons in layers; the first complete layer consisting of two, the second and third of eight electrons each; the valency being an excess above or a deficit below a complete layer. The elements with $+v$ are often

described as positive, those with $-v$ as negative. In any compound of two atoms in which the atomic number of one contains $+v$, and that of the other contains $-v$, the total 'molecular number,' M , will be $2 \times 2 + 8(d+d')$, where d and d' may be the same or different. Similarly, in a compound containing a atoms, with the sum of the $+$ valencies equal to that of the $-$ valencies, the total molecular number will be $a \times 2 + 8(d+d'+\text{etc.})$, where $(d+d'+\text{etc.})$ is an integer n . This is Mr. Tibyriçá's formula. In minerals, which are compounds, consisting only of elements with numbers from 2 to 21, all combination is between elements with $+$ valency (including for this purpose the tetrads) and those with $-$ valency, and their valencies are all satisfied. The only exception of which I am aware is carbon monoxide, which undoubtedly exists in a natural state.

So far, the element hydrogen has been left out of consideration. Its atomic number, $2+8 \times 0-1=1$, satisfies the same conditions as do the other elements up to 21, but though it has a $-$ valency of 1, it behaves as an element with $+$ valency and combines with elements with $-$ valency, instead of those with $+$ valency; thus water or ice would not satisfy Mr. Tibyriçá's formula. For $M-2a=2+8-6=4$, which is obviously not divisible by 8. If the elements of an even number of molecules of water be present in a molecule and the other elements present satisfy the formula, the mineral as a whole will do so. But if only the elements of an odd number of molecules of water be present, it will not. Thus, if tavitockite have the formula $\text{Al}_2\text{Ca}_3(\text{OH})_6(\text{PO}_4)_2$, Mr. Tibyriçá's formula would not apply. For $M=234$ and $2a=54$; so that $M-2a=234-54=180$, which is not divisible by 8. But it appears that in calculating the number of atoms, a , he does not include atoms of hydrogen, though he includes their atomic number in calculating M . Consequently for water $M-2a=2+8-2=8$; so that for minerals with an odd multiple of the elements of water, $M-2a$ is still divisible by 8.

J. W. E.

Progressive Lightning.

I HAVE read with interest Prof. Boys's comments on the phenomena of "Progressive Lightning" in NATURE for Feb. 19 last. The object of this present note is to direct attention briefly to some considerations in connexion with that phenomenon which occurred to me after writing my note of Dec. 19, and do not appear to have been discussed so far as I know, and to clarify and supplement some points brought out by Prof. Boys.

At the outset I must say that I have made no especial studies of these phenomena, but have simply observed them as one interested in all Nature. The generally accepted explanation of the multiple flashes as progressive discharges through a channel rendered a better conductor by the preceding discharge, was seemingly so sound and reasonable that it was a profound surprise to note what appeared to be different behaviour of the near flashes. I would be glad to supplement my visual observations by photography, but that is impossible. I have more investigations in hand now than I can finish, and my experience has invariably been that even an apparently simple problem reveals so many by-paths and requires so many subsidiary investigations that it becomes a major one before a solution is reached—if ever.

Prof. Boys's observations of close-by multiple flashes seems to set at rest the question of the phenomena depending only upon distance, as my observations seem to indicate. He quite properly raises the point of a near flash blinding the eye to

subsequent ones. In my own case this can scarcely be the explanation of the failure to observe multiplicity in the near-by flashes, because many of those very close were not seen directly but by their general illumination, which is not sufficiently blinding and would not prevent noting subsequent ones. Many were also observed in day time, when blinding is much less likely to occur. Certainly a negligible number of my observations could have been so affected.

After sending my former note another fact impressed me, namely, that the general glare accompanying distant flashes appears also to be of greater duration than those near by, about in the same ratio as the flashes themselves. This is very difficult to explain on almost any hypothesis. Ordinary refraction or reflection phenomena alone appear inadequate, as the great velocity of light would limit such effects to a negligible fraction of a second.

It may be urged that there will be a persistence of such phenomena so that the duration will appear sensible. There is no reason, however, that I can see, why such persistence of vision should be greater in distant than in near flashes.

While I feel some confidence in the reality of the difference between near and distant flashes observed here, I also feel that it should be confirmed by photographic observations before considering it as established, because of Prof. Boys's observations of multiplicity in near-by flashes and because of theoretical objections. I should hesitate to believe that there was any essential difference in such phenomena here and in England, for example, without further evidence.

I have considered only discharges of lightning to earth, because discharges between clouds seemed to present some anomalies.

C. D. PERRINE.

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Nación Argentina,
Cordoba.

BEING essentially an experimentalist, I am of opinion that the subject of "Progressive Lightning" is one for experiment rather than discussion, and that the simple apparatus for causing two images to move at equal speeds upon the photographic plate but in opposite directions so as to obtain opposite aberrations, which I described in NATURE of Nov. 20 last, is likely to give direct information as to fact. Dr. Simpson has this now, and I am hoping that the experiment may be made also in America, where the method has attracted some attention.

C. V. BOYS.

Rotation of Dielectric Bodies in Electrostatic Fields.

REFERRING to the letters by the late Dr. S. W. Richardson and by Mr. G. L. Addenbrooke in NATURE of Feb. 12 and Mar. 12 respectively on the rotation of dielectric bodies in electrostatic fields, the following may be of interest.

We have recently observed that if the metallic points of a Hamilton reaction mill or 'electric whirl' are replaced by dry wooden points, the normal direction of rotation is reversed; that is to say, instead of rotating in a direction *opposite* to that toward which the points are directed, the mill with wooden points rotates in a direction the *same* as that toward which the points are directed. The cause of the rotation under these conditions must then be quite different from that when metallic (good conducting) points are used—where the explanation is that ions are produced in the immediate vicinity of the point by the process of ionisation by collision, those of *opposite* sign to the charge on the point are

immediately drawn into it, those of the *same* sign are repelled, and that the rotation is due to the mutual repulsion between the swarm of latter ions and the charge on the point.

It is interesting to note that a wet point (we used ordinary matches for points) will rotate in the normal direction at first, then, as it dries, decrease its speed, come to rest, and finally begin to rotate in the opposite direction.

Rectangular blocks of paraffin mounted non-symmetrically on the arms of the mill (two straight brass arms were used mounted on the head of an ordinary speedometer connected to one pole of a large Holtz machine, the other pole being connected to a plane wire netting suspended in a horizontal plane above the rotating arms and parallel to them) behaved in a similar manner to the dry matches, *i.e.* rotated in the direction toward which the greater part of the block protruded. In the dark in the latter case, extensive brushes could be seen on the arms near the paraffin, and there is no doubt that the action of the block is to form a non-symmetrical brush, which drives the arms much the same as the brush from a metallic point drives it. The brush, of course, is formed on the side of the block which protrudes least from the arm in the plane of rotation.

In the case of the matches the cause of the rotation is not so clear. Only a faint glow can be observed on the end of the match. It seems likely, however, that the action of the dry match is to disturb the faint (silent) discharge from the arms of the mill, retarding it on the side toward which the match protrudes, so that the major portion of the brush forms on the side of the arm opposite to the match and so drives the arm in the direction toward which the match extends. This point is still under investigation.

A. W. SIMON.
J. M. CAGE.

California Institute of Technology,
Pasadena, California.

Yolk Formation in some Arthropods.

THERE has recently been controversy between Harvey on one hand and Gatenby and Vishwa Nath on the other, as to the relationship of Golgi apparatus and mitochondria to yolk formation.

I have been myself engaged on this particular problem for the last year or so. A brief account of a portion of my work in collaboration with Dr. Vishwa Nath was published in *NATURE* of Nov. 6, 1926. I have since then worked out three more arthropod forms, namely, *Musca domestica*, *Forficula* and *Porcellio*. The relationship of yolk formation to the cell inclusions may be described as follows.

In *Musca* the nucleolus divides at a very early stage and the various nucleoli begin to fragment. These fragments soon escape into the cytoplasm but do not undergo any further fragmentation. Simultaneously with the escaping of these extrusions, a fuchsinophil yolk arises in masses all over the cytoplasm. In *Scolopendra* (Nath and Husain) a similar though not identical relation has been noticed between this yolk and the extrusions. In *Forficula* the fragmentation of the nucleolar extrusions has been followed in most eggs. In *Porcellio*, the nucleolus does not fragment at all, and it is interesting to note that there is no proteid yolk in this form.

In all three cases both the Golgi apparatus and mitochondria have been observed. The latter are always granular and never filamentous. They are seen to divide but never swell up into yolk of any kind. The Golgi apparatus is seen as a juxta-nuclear mass in the younger eggs of all forms. It is always in the form of dots and dashes and never discoid. It

does not arise *de novo* in the cytoplasm but is formed by the multiplication of the pre-existing Golgi elements. In *Forficula* and *Porcellio*, free fat arises directly by a metamorphosis of the Golgi apparatus. In *Musca* the latter never swells up, and in correlation with that it is interesting to note that there is no fatty yolk in this form.

A detailed account will be published later.

MIAN TASDIQUE HUSAIN.

Department of Zoology,
Government College,
Lahore (Punjab),
April 11.

Soft X-ray Spectra.

ALTHOUGH much general information of soft X-ray spectra can be obtained by photoelectric methods, there is an urgent need for its direct spectroscopic confirmation. Dauvillier (*Jour. de Phys. et le Rad.*, 8, 1; 1927) has recently photographed some lines of boron, carbon, oxygen, and thorium between 25 Å.U. and 125 Å.U. by refined methods of crystal spectrometry. Spectra in this region can also be obtained from a concave glass grating if it be mounted at a sufficiently large angle of incidence.

Using the anticathode of an X-ray tube as a source of radiation, I have, by this method, obtained photographs of some fifteen lines between 40 Å.U. and 200 Å.U. Their interpretation requires some care, since, in general, the same lines appear whatever the nature of the anticathode. The *K* line of carbon (44 Å.U.) is present on all plates, though in varying intensity, due presumably to the destruction of residual vapours in the tube. The *L* lines of carbon and the *K* and *L* lines of oxygen and nitrogen fall outside the region covered by these experiments; as possible causes of the observed spectra there remain strontium, barium, and platinum deposited from the filament on the cold anticathode. Perhaps the most prominent of the lines which have so far been fitted into the scheme of X-ray levels is the $M_{1,2}$ doublet of strontium ($\lambda = 159, 160.1$ Å.U.). A few lines appearing faintly on the photographs seem to be due to the anticathode itself—lines associated with the *M* levels in the case of zinc, copper, and iron.

A curious feature of the spectrum of aluminium is the presence of a kind of band, with a sharp limit at 166.6 Å.U., shading off towards longer wave-lengths. It appears to be not without structure, though this cannot be definitely asserted until further experiments have been performed.

It is worth mentioning that spectra in this region can also be obtained from a grating of speculum metal, though with considerable difficulty; and that Schumann plates are at least fifty times as sensitive as X-ray plates, even though they are treated with a fluorescent oil.

T. H. OSGOOD.

Ryerson Physical Laboratory,
University of Chicago, April 11.

Consideration of Six Cases in Zoological Nomenclature.

THE Secretary of the International Commission on Zoological Nomenclature has the honour to invite attention of the zoological profession to the fact that application for 'suspension of the rules' has been made in the six following cases:

I. *Odontaspis* Agassiz to be retained with *Carcharias taurus* Rafinesque as type.

II. *Eulamia* Gill to be retained for *Carcharias* Mueller and Henle (not Rafinesque, 1810).

III. *Carcharodon* Mueller and Henle, 1838, to be retained.

Cases I., II., and III. would involve treating Rafinesque's *Caretteri* (April 1810) and his *Indice* (May 1810) as two parts of one and the same paper.

The rigid enforcement of the rules would retain *Carcharias* vice *Odontaspis*, *Eulamia* vice *Carcharhinus*, and *Carcharhinus* vice *Carcharodon*.

IV. In *Aëtobatus*, *Raja* (*Aëtobatus*) *vulgaris* to be understood as *Raja aquila*, for which it was obviously intended. This replaces *Myliobatis* Cuvier and leaves *Stoasodon* for *narinari*.

V. Suppression of "Synoptisches Verzeichnis . . . der Baikalflohkrebe" in *Bull. Internat. Acad. Pol. Sci. et Let.*, 1926, pp. 1-77, from nomenclatorial consideration. Examples of generic names used: *Siemienkiewicziechinogammarus*, *Cancelloidokyotodermogammarus*, *Loveninuskytodermogammarus*, *Parapallaseakytodermogammarus*.

VI. *Lithostrotion striatum* Fleming, 1828, to be declared genotype of *Lithostrotion*, in place of *L. floriforme* designated by Edwards and Haine, 1851.

Zoologists interested in these cases are cordially invited to communicate their views to the Commission not later than Jan. 1, 1928.

C. W. STILES.
(Secretary.)

U.S. Public Health Service,
Washington, D.C.

Odours and Visual Imagery.

THE relative inhibition of cortical brain functions and the progress of uncritical activities, such as imagery, during the initial and terminal phases of sleep (cf. *NATURE*, Aug. 7, Sept. 11, and Oct. 30, 1926), may find a parallel in certain cases of visual imagery induced by odours. The following illustration may be of interest. A small bottle containing methyl salicylate was associated consciously and deliberately with a number of circumstances in which some experiments had been carried out three or four years ago. On withdrawal of the stopper, the odour induced a visual image of a medical practitioner in a bedroom, merging into the image of a table with a tumbler of water and a spoon. Afterwards, the image, or images, were found to be as blended as the content of a dream, since the room, the doctor, and the table, had to be referred to widely separated times and places. *Litera odorata manet*.

The similarity between such a smell association and dream phenomena calls to mind the argument put forward by Dr. Halliday (*Glasgow Med. Jour.*, Mar. 1926) as to the correspondence between verbal aphasia conditioned by deterioration of the neopallium and the natural aphasia as regards names for smells, due to the absence of higher integrating levels in the archi-pallium.

The above considerations, together with numerous records of smell associations, reinforce a suggestion (*Brit. Med. Jour.*, 1922, i. p. 904) that odours should be used in psycho-analytical practice. In the treatment of neuroses on analytic lines, the overcoming of a high resistance in certain patients by means of images recalled by olfactory stimuli has been found recently to be of some considerable practical value.

J. H. KENNETH.

The Homestead, Clynder,
Dumbartonshire, May 3.

Effect of Temperature on the Refractive Index of Rocksalt.

WE are writing to direct attention to a source of error which may occur in spectroscopic investigation of the infra-red region of the spectrum. On reviewing the literature in which experimental work in this

region is reported, we find that usually no note is made of the temperature of the prism at the time when the experiment is being conducted. In the course of investigations which we have been carrying on for some time on the absorption of gases in the near infra-red, we have had occasion to observe the important effect of temperature on the refractive indices of rocksalt and fluorite. Thus, a variation of 5° in the working temperature would result in a difference of so much as 0.075 μ (about 180 wave numbers) in certain parts of the near infra-red.

The commonly adopted practice of accepting the 4.4 μ emission band of carbon dioxide, or the quartz reflection bands, as bench marks is misleading unless combined with suitable temperature corrections of the prism used. It is our intention in the near future to deal with these matters fully and to describe the procedure we adopt to ensure greater accuracy in the determination of infra-red bands with prism apparatus.

R. ROBERTSON.
J. J. Fox.

Government Laboratory,
Clement's Inn Passage,
Strand, London, W.C.2, May 17.

The Industrial Revolution.

MISS BUER, in *NATURE* of May 7, p. 671, is, I think, under a wrong impression in stating that the use of Newcomen's engine (in England) was not widespread. Statistics are not available, but in 1769, John Smeaton obtained a list of 99 engines that had been erected in the Newcastle-upon-Tyne district alone. Pryce, in "Mineralogia Cornubiensis," 1778, gives the figure for Cornwall as 60 at that date. We have to reflect that the materials of one such engine might cost £1000, and its annual upkeep £200.

Nor is there any evidence that the engine "was frequently abandoned owing to the wasteful consumption of fuel." The engine was only applicable to pumping, and its largest sphere of usefulness was at collieries, where fuel consumption was scarcely a consideration at all. An engine was abandoned or transferred when a mine was given up. Far from being 'experimental,' as suggested, the longevity of these engines was sometimes extraordinary, e.g. the one in the Science Museum, South Kensington, was in service for more than a century and a quarter.

H. W. DICKINSON.

The Science Museum,
South Kensington, S.W.7.

Hardness of Metals in Relation to Periodicity.

IN Mr. Mallock's letter (*NATURE*, Feb. 19, page 276) he states that the periodicity of the hardness he determined does not fit Mendeléef's table. It is interesting to note that the hardnesses, and incidentally also the melting-points, fit rather well into the 18-period spectroscopic table which will be found on page v of the appendix of "Astronomy," by Russell, Dugan, and Stewart. Inspection will show that the hard and soft metals are grouped and differentiated, and sequences with rather well-defined maxima and minima may be observed.

A possible interpretation lies, I believe, in the electronic configuration of the atom in question. Those with the complete electron shells, as for example the rare gases, have low melting-points, whereas those with the shells about half complete, such as tungsten, osmium, and carbon, are the hardest, and with highest melting-point.

S. A. KORFF.
Princeton University,
New Jersey, May 4.

The Progress of Hittite Studies—I.¹

By Prof. J. GARSTANG.

THE remarkable development in Hittite studies, which the circumstances of the War tended to obscure, now merits the attention of all students of history. This progress is due not so much to the results of excavations or further exploration, interesting though these be, as to the decipherment of an important section of the Hittite archives from Boghaz-Keui which opens the doors to more than one library of contemporary documents. The clue was found and established on an Indo-European basis, by Prof. Hrozný of Prague in the early years of the War. Since then a circle of eminent German philologists (amongst whom may be mentioned Drs. Weber, Forrer, Weidner, Figulla, Götze, as well as Profs. Friedrich, Sommer, Zimmern, and others) has placed the new study on a scientific basis by the continuous publication of texts and transcriptions no less than by philological and critical discussion. A new light plays upon Asia Minor under the Hittite kings.

It is both interesting and instructive to look back at the origins of the subject. The Hittites have long been known, from the numerous references in Biblical literature, either as scattered settlers in Palestine or as military peoples in the north of Syria. The latter impression was confirmed, from the time when Egyptian hieroglyphs came to be understood, by scenes and inscriptions on Egyptian temple walls depicting the conflicts of the Pharaohs with this war-like rival, whom they encountered in Syria and called Ḫ-t-3. Two generations ago Dr. Wright hypothesised that certain unexplained hieroglyphic inscriptions found at Hamath and elsewhere in northern Syria must pertain to the same peoples. French scholars and others adopted the idea, and it was recognised that the distribution of such inscriptions was not confined to Syria; but that ruined cities, religious sculptures, and numerous groups of pre-Hellenic monuments bore witness to the same culture-influence in Asia Minor itself. Then Prof. Sayce, who lives to see the verification of his far-sighted conclusions, after examining and comparing certain inscribed sculptures on the western coast near Ephesus, constructed his theory of a long-forgotten Empire of the Hittites, whose kings held dominion over Asia Minor and played their part in oriental history so long before the fall of Troy that their memory scarcely survives in Homeric legend. It was these kings who descended from beyond Taurus and battled with the Pharaohs in the fourteenth and thirteenth centuries B.C.

A theory so comprehensive, albeit plausible, was naturally followed by a period of reactive scepticism and investigation. It suggested, none the less, the lines of practical research. British explorers and scholars, notably Ramsay, Hogarth, Anderson, and others, joined in the quest: new materials were found and cautiously examined.

Early in this century English and American universities (Liverpool, Cornell, and Princeton) organised expeditions to collate materials and collect new data. Asia Minor being diplomatically closed, excavations were undertaken by the Liverpool institute and by the British Museum at promising sites in northern Syria.

Meanwhile the German Orient Society had received permission to excavate among the remains of the largest ruined city of pre-Hellenic character in Asia Minor, at Boghaz-Keui, a small village in the north-east of the plateau within the circuit of the Halys River; and there Dr. Winckler, early in the work, had the fortune to discover hundreds of fragments of inscribed clay tablets, numbers of which were in Semitic and could be read. They contained names of Hittite kings and places (some of which could be recognised), names of Syrian princes known from Egyptian sources, records of campaigns and negotiations in Mesopotamia and in Syria; and, most important for history, the names of contemporary Egyptian rulers. Being present at the time, the present writer was courteously permitted to investigate the circumstances of the discovery, and shared in Dr. Winckler's anticipations. It was clear that these tablets contained imperial archives; their presence seemed to fix the royal palace there where they were found, and this was soon confirmed. The Hittite capital was called Ḫattušaš, the homeland Ḫatti. The latter was clearly the counterpart of the Egyptian Ḫ-t-3. Not only was the Hittite Empire a reality, but the Hittite kings emerged into the full light of history, claiming their part in the contemporary events of near Asia. There remained an apparently inexhaustible supply of documents to be scrutinised, but a great proportion was found to be unintelligible though written in cuneiform script. Dr. Winckler was able, however, to publish before his death a number of the Semitic texts, chiefly concerning affairs in Syria, some of them narrating events of which parallel accounts existed from the Egyptian sources, including references to and a draft of the treaty with Rameses II. Hittite studies stood at that stage when last reviewed at the Royal Institution under the same title nineteen years ago.

It now appears from various sources that about 20,000 tablet fragments were recovered, for further discoveries were made in the next year of work. From these some 700 documents have been reconstructed and about 260 have been published. Analysis shows that, apart from the Semitic texts, six 'native' languages are involved, and of these only one, which we may call for the present 'official Hittite,' can be translated with certainty. This language is called by some Kanesic. It forms all kinds of words by suffixes, and three-quarters of its grammatical forms are to be found in Indo-European languages in the same sense. It is safe to premise at any rate a common even though

¹ Summary of three lectures delivered at the Royal Institution on Feb. 24, Mar. 3 and 10, 1927.

remote parentage (Proto-Indo-European). Hittite names, on the other hand, are prefixing, and analogy is to be sought rather in the Caucasus. In Mesopotamia, again, the Mitannian rulers' language was seemingly Aryan with Sanscrit affinities, differing from the common language of the area, which also has Caucasian elements.

The difficulty of language was evidently felt by the archivists of the time, for glossaries were compiled for the translation of unfamiliar expressions, and some documents were set out in parallel bilingual columns. The tablets were in fact the contents of royal libraries of the thirteenth century B.C., and many of them are copies of older documents that had been damaged. They cover a vast range of subjects, from imperial affairs to domestic detail. Treatises on non-political matters were so numerous as to call for a proper inventory or catalogue by the names of authors (both male and female). Among the state documents or copies of them, those of most immediate interest historically include foreign correspondence with Egypt and with Babylonia, correspondence and treaties with the Amorite chieftains of Syria and the smaller states to the north (Aleppo, Nukhašše, Barga, Carchemish, etc.); treaties with a Mesopotamian (Mitannian) prince, as well as private letters between the members of the various royal families. Happily for us to-day, a historical instinct pervaded the foreign office of the time, so that many treaties contain preambles setting forth in chronological sequence the outline of events and past relations between the contracting states or princes down to the framing of the new agreement. These prefaces contain names of old-time kings and places, records of campaigns and rebellions and former treaties. They can be checked in some cases by the prefaces to earlier or later treaties, and occasionally by allusions in documents relating to other states. They are new materials for history; and it is already possible to reconstruct and trace in outline the development of the imperial organisation, in which diplomacy and military genius play a leading part.

The earliest references to Hatti occur in the

Babylonian records of Sargon and Naram-Sin of Agade, which take us back before the middle of the third millennium B.C. It would appear that Hatti was at that time one of the leading tribal areas of Asia Minor. After an interval which can only be approximated at about 500 years, the Hittite archives indicate a period of struggle for the over-lordship of Asia Minor: the first Great-King whose dominion reached to "the sea" and included Hatti, resided at Kuššar. Thereafter there is record of some forty-nine Hattic rulers, whose reigns cover approximately the thousand years ending with 1200 B.C. An important synchronism is found in the annals of an early King Mursil, who claims to have captured Aleppo and Babylon, and it is confirmed by the Babylonian records that this invasion brought the first Babylonian dynasty (that of Hammarabi) to an end. Unfortunately, the date of this event is not agreed on by Babylonian scholars, being variously estimated as between 1950 B.C. and 1750 B.C. Further study of the Hittite archives may help to settle that point and others connected with the Hyksos period.

When first Hatti became dominant among the Hittite tribes of Asia Minor, their kings continued, it would appear, to reside at Kuššar, but from the epoch of the sack of Babylon the capital is found fixed at Hattušaš, and so continued with possible political interruptions until the end. Aleppo claimed great power and temporary independence a century or so later, a date which may have fallen within the Hyksos period. From about 1470 B.C. onwards the records of the Hatti dynasty are continuous, comprising twelve consecutive reigns, some of which are described with instructive detail. Relations direct or indirect with Egypt under the eighteenth dynasty, particularly the penetration of Subbiluliuma into Syria (period of the Amarna letters), the battle between Mutalliš and Rameses II., and the treaty of Hattušil III. with the same Pharaoh, give a series of fixed chronological positions on which the framework of international events can be constructed.

(To be continued.)

Wave Mechanics and Classical Mechanics and Electrodynamics.

By Prof. G. A. SCHOTT, F.R.S.

RECENT articles in this journal by Mr. R. H. Fowler, Prof. M. Born, and Dr. P. Jordan have dealt with the relation between Schrödinger's wave mechanics and the quantum theory, but it is admitted that they scarcely express the views of Schrödinger himself or those of his predecessor, L. de Broglie. The object of the present article is to give an account of the researches of these two authors from the viewpoint of classical mechanics and electrodynamics, to which they are closely related, both in subject-matter and method. A brief bibliography of their papers, as well as a few by other writers on the same subject, is appended, to which the reader is referred for details, for an

outline only of the line of thought can be given in the present article.

The root of these researches is to be found in the papers of Sir W. R. Hamilton, published a century ago, in which he pointed out the close analogy subsisting between Fermat's Principle of Least Time in optics and Maupertuis' Principle of Least Action in dynamics. Just as Fermat's Principle enables us to trace the paths of light rays with considerable accuracy when the linear dimensions of our apertures and obstacles are large compared with the wave-length of light, but fails when they are so small that diffraction becomes important, so Maupertuis' Principle enables us to predict the

paths of material particles accurately so long as the linear dimensions of the paths are sufficiently large, but fails when they are of atomic dimensions. In such cases we must resort to the methods of wave mechanics.

So much being premised, we may summarise de Broglie's argument thus: every element of energy—electron, proton, or quantum—is associated with a periodic phenomenon, not specified, whose frequency is given by Einstein's equation, whether the element be at rest, or moving with uniform velocity v relative to the observer. In the latter case the periodic phenomenon at a point fixed to the moving element appears to be slowed down, like a moving clock in the theory of relativity, but at a point fixed in the observer's frame of reference it appears as a phase-wave, propagated in the direction of relative motion with the phase-velocity $u=c^2/v$. The velocities u and v are related as wave- and group-velocity respectively. Einstein's frequency equation, together with the Principle of Invariance, makes the momentum-energy four-vector of the moving element a constant multiple of the wave-vector of the associated phase-wave, whence it follows that the Action of the element is a constant multiple of Fermat's time-integral for the phase-wave, so that the Principles of Least Action and Least Time are equivalent, a result generalised by E. Schrödinger and L. Flamm.

Moreover, the quantum integrals of Bohr and Sommerfeld, being essentially Action integrals taken round closed orbits of electrons, are proportional to phase-integrals taken round rays of the associated phase-waves, which rays are identical with the corresponding orbits. Hence the quantum conditions, which state that the quantum integrals are integral multiples of Planck's Action constant h , are equivalent to the conditions for resonance between the electrons and their associated phase-waves, which state that the changes in phase of the phase-waves in passing round the orbits of their respective electrons are integral multiples of the wave-lengths.

With de Broglie the concept of the electron or other element of energy is primary, whilst that of the phase-wave is secondary, but with Schrödinger the position is reversed. In his theory the principal part is played by the so-called wave-function ψ , which determines the phase-waves and is a solution of a linear partial differential equation of the second order of the type of the wave-equation in classical mathematical physics. The electron, or element of energy, becomes merely a focus of a group of phase-waves, and in the atom, where the focus is ill-defined, it loses its individuality altogether. In order to re-establish contact with electrodynamics, Schrödinger finds it necessary to introduce a new and at first sight arbitrary hypothesis, defining the density of electric charge in terms of the wave-function, but justified by the results to which it has led at the hands of Schrödinger himself, of A. Sommerfeld and his pupil F. G. Slack, and of J. C. Slater.

Originally, Schrödinger deduced the wave-equation from a form of the Principle of Least

Action suitably modified to suit a continuum of n -dimensions. He takes an integral—which we shall call I for the sake of brevity—of the form $I = \int (H - E) \mu d\omega dt$, where H is the Hamiltonian function, expressed in terms of generalised co-ordinates q and momenta p , E is the total energy, μ a suitable factor, used if necessary to make the integral invariant, and $d\omega$ is an element of extension of the q -space of n dimensions. He then replaces p by $\partial S / \partial q$ as usual, where S is Hamilton's characteristic function, puts $S = K \log \psi$, where K is a constant of the dimensions of action, and ψ the wave-function, chooses μ to be proportional to $\psi \bar{\psi}$, where $\bar{\psi}$ is the conjugate of a complex ψ , and finally makes the integral I stationary by varying ψ . This somewhat arbitrary process by the usual method yields the wave-equation. For a particle moving in 3-dimensional space it reduces to

$$\nabla^2 \psi + \frac{2m}{\hbar^2} (E - V) \psi = 0,$$

where m is the mass of the particle, and V the potential energy. In his later papers Schrödinger postulates the wave-equation once for all; it has been generalised in various ways, which need not be particularised here, by Schrödinger himself and others, notably de Broglie, L. Flamm, and O. Klein.

In general the potential energy V introduces singularities into the wave-equation, and we must seek a solution ψ , which shall be one-valued, finite and continuous even at the singularities. The conditions that this may be the case automatically select values of the energy constant E and corresponding energy levels and normal frequencies, which are alone possible for stationary processes in the system, without any appeal to extraneous quantum conditions. Thus the singularities of the wave-equation are analogous to the boundaries in such classical problems as that of the motion of a stretched string or membrane.

For example, in the problem of the hydrogen atom we have $V = -e^2/r$ in the usual notation; the singularities are $r=0$ and $r=\infty$, and the corresponding conditions make all positive values of E possible, but only a discrete series of negative values, given by $E = -me^4/2K^2l^2$, where l is an integer. The former determine a continuous series of infinite electronic orbits; the latter a discrete series of finite orbits, agreeing with Bohr's stationary orbits, if we put $K = h/2\pi$. In order to obtain the Balmer series Schrödinger assumes that the normal frequency is approximately a linear function of E —a relation which he states is exact on a relativity theory—and deduces that the lines of the series arise from beats between normal modes of vibration simultaneously present in the atom. In later papers he solves other problems, such as those of Planck's oscillator and the rotational oscillator, and introduces a method of perturbations for the study of more difficult cases, such as the Stark effect and the problem of dispersion and resonance, but we cannot describe his results in detail here.

In his second paper, Schrödinger pursues the analogy between Hamilton's Principle of Varying

Action and Fermat's Principle of Least Time for the propagation of waves in an n -dimensional space, now using Hamilton's Principal Function $W = -Et + S$ in place of S . The surfaces $W = \text{constant}$ are the wave-surfaces, propagated with the phase-velocity $u = E/\sqrt{2(E - V)}$, and belonging to a progressive wave-motion in the q -space. The image of the mechanical system in this space, which is determined by the instantaneous values of the co-ordinates q , moves along an orthogonal trajectory of the wave-surfaces—a ray—with the velocity $v = \sqrt{2(E - V)}$, so that $uv = E$. On the assumption that the waves have a time factor $\sin(2\pi W/h + \text{constant})$ the frequency is given by Einstein's equation $\nu = E/h$, and v becomes the group velocity corresponding to the phase-velocity u , a generalisation of de Broglie's result, but obtained from classical mechanics and not from relativity. Schrödinger concludes that a group of approximately monochromatic waves, of dimensions of many wave-lengths in all directions, represents a material particle, but only when the path is large compared with a wave-length. Then Jacobi's dynamical equations show that the image of the mechanical system always coincides with that point of the q -space at which a certain continuum of waves of the group are all in the same phase, thus constituting a 'packet of waves.' A one-dimensional example of such a packet is given in Schrödinger's paper in *Die Naturwissenschaften*. But this representation by an image is only approximate and fails for atomic systems, owing to the indefiniteness of the image; in such cases the true representation of the actual mechanical phenomenon is given by the wave-motion in the q -space and this must be determined from the wave-equation.

To overcome the indefiniteness attaching to the notion of the electron in atomic systems, Schrödinger defines the density of the electric charge, coupled with one of the mass-points of classical mechanics, as the integral, taken over the system co-ordinates of the remaining mass-points of the system, of the product of the classical charge of the selected mass-point by the value of $\psi\bar{\psi}$ at that point, where ψ is the conjugate of ψ , when both are complex quantities, ψ and $\bar{\psi}$ being of course normalised to unity. This hypothesis, already referred to above, is really indicated by the choice of the factor μ in the Action integral I , which is clearly proportional to the material density in the q -space, though Schrödinger apparently makes no mention of this connexion. Since it gives results in accordance with experiment and, moreover, agrees with the relativity definition of the electric current vector, there is a good deal to be said for it.

In conclusion, it need only be said that Schrödinger's wave-equation method has already yielded results including and even transcending those obtained by the various quantum theories, and offers a fair prospect of explaining quantum phenomena by means of the methods of classical mechanics and electrodynamics.

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Obituary.

PROF. G. O. SARS.¹

THE name of Georg Ossian Sars, who died on April 9 at eighty-nine years of age, has been classic to every marine zoologist for three generations—indeed since the elder, Michael Sars, then a clergyman at Florø in western Norway, published his "Beskrivelser og Jagttegelsler" (1835), followed by other important memoirs which by and by led to his appointment to the chair of zoology in Oslo (Christiania) in 1854. Born in 1837, Georg Ossian Sars had the priceless example of a distinguished father and a sympathetic home, where his innate enthusiasm for marine zoology was welcomed and encouraged in no ordinary degree. Thus from early youth onward almost to his ninetieth year, the talented brain and hand unceasingly laboured at his cherished subject with a success almost unrivalled in modern times.

After a careful training in the schools of Bergen and Christiania, Sars entered the University of the latter city, where he distinguished himself in geography and natural history, finally receiving

a gold medal for his researches on Crustacea. His original contributions to marine zoology thereafter began with a paper on the Cladocera in the 'sixties of last century, and by and by ranged over the whole field from Protozoa upward, so that he has left a remarkable record.

When still a young man (in 1864), Sars became a member of the Fisheries Scientific Research Committee and had facilities for studying the development of the cod off the Lofoten Islands (where his father had worked before him) on the north-west coast of Norway. He found that the cod, contrary to the general opinion, spawned in midwater, and that the eggs were pelagic, that is, float in the water, as a rule—indeed, keeping near the surface—as likewise do the newly hatched larvæ; and so with the haddock, flounder, and mackerel. We can imagine the eagerness with which he would have welcomed a marine laboratory for these and other researches in touch with his University and his class, as at fortunate St. Andrews. A skilful artist (for his touch on the black-board always delighted his students), he made a series of coloured drawings of the various stages in the developing cod, and sent

¹ I have thankfully to acknowledge information concerning the deceased naturalist from Dr. Nansen, Prof. Nordgaard, and Dr. Calman.

them to the Great Fisheries Exhibition in London in 1883, where they attracted the attention of all marine zoologists, and stimulated those specially interested in the fisheries to further investigations. He was truly the pioneer in this department and was worthy of the distinction, though subsequent observations demonstrated that the ways of Nature in the ocean are not at the mercy of currents. Thus, for example, the young cod, hatched in the offshore, seek the rocky margins of the inshore when about an inch in length, whilst the haddock passes this stage in deep water. The herring, moreover, appears to be independent of drift and currents, its eggs being adherent to the bottom, producing larvæ and young which remain near their birthplace until their powers of swimming enable them to follow Nature's instincts. Currents, again, will not fully explain the life-history of the eel. Be this as it may, G. O. Sars has the honour of leading the way into this important field. In 1874 he was appointed to the chair of zoology in the University of Oslo as successor to Prof. Halvor Rasch.

Sars' continuous researches in marine zoology during a long life are almost unequalled in the history of the subject, and strike the observer both with respect and amazement. Not only did he largely extend the boundaries of knowledge in relation to his own wonderful seas (not to allude to his work in editing various posthumous memoirs of his father), but also most of the important expeditions, from the *Challenger* to the "Voyages of the Prince of Monaco," sent him materials for study. Further, collections from New Zealand and Australia, China and the Polar Sea, South and Central Africa to Tanganyika and other places, furnished materials for his eager microscope, even dried mud from Australia and New Zealand disclosing new forms to the indefatigable worker. Moreover, when we reflect that whilst his special studies centred in the wide field of the Crustacea with autograph figures of all the Norwegian species, his unceasing labours comprehended Protozoa, Coelenterates, Echinoderms, Bryozoa, Annelids, Mollusca (including a volume of 446 pages and 52 autograph plates on those of Norway), and even added to our knowledge of the Blue Whale and the Finner, our admiration is involuntary. No self-seeking element was there, only the inborn and genuine love of Nature and her works. His numerous original memoirs were mostly illustrated by his own facile pencil and brush, and when it is mentioned that no less than two thousand two hundred and thirty plates—including a few maps—were a portion of the result of his untiring zeal, some idea of the stupendous task may be estimated, a task at which even a more robust frame may have quailed. His studies on the copepods alone were sufficient for a reputation.

Sars' strenuous life made him more or less a recluse, but he was beloved by his students and friends, and he was ever ready to help a scientific visitor from other countries with his great knowledge and experience. As a foil to his labours he was wont to solace himself with his violin, as befitted a member of a musical family. Of a wiry

frame and with refined features and dark hair like his mother and his late charming and accomplished sister, Mrs. Fridtjof Nansen, he was enabled to carry on his researches until a week or two before his somewhat sudden death—from weakness and old age. He passed away just as his colleagues, friends, and pupils had thought to celebrate the old scientist's birthday, and they had to be content with assembling at the grave to pay a last tribute. Yet though his hair whitened and his sight became dim, whilst the cramp of age somewhat affected his writing, his drawings to the last lost little of their pristine firmness and beauty—so much valued in his early years by his father. His long and busy life of unswerving devotion to marine zoology was as noble as it was rare. His career throughout was an honour to science, to his country, and to his race, and though Norway has a roll of many distinguished zoologists and explorers, it will be long before so enthusiastic and so persevering a student of the rich creeks, bays, and seas of his native country will be found.

Sars was an honorary member of numerous scientific societies in Europe, the United States, and New Zealand. He was also Commander of the 1st Order of St. Olav of Sweden; indeed, he was the recipient of many honours appreciative of his distinguished services to science. W. C. M.

PROF. M. F. FITZGERALD.

PROF. MAURICE FREDERICK FITZGERALD, B.A. (Dublin), D.Sc. (Belfast), was born on July 10, 1850, and died on May 4. The eldest son of the late Right Rev. Wm. FitzGerald, Bishop of Killaloe, he came of a family greatly distinguished in science. A brother of the late Prof. George Frances FitzGerald, F.R.S., and nephew on the mother's side of the late George Johnston Stoney, F.R.S., and Bindon B. Stoney, F.R.S., the eminent engineer, he early showed mental powers of a high order. He entered Trinity College, Dublin, in 1867, gained a scholarship in mathematics, and graduated with honours in 1871. In the following year he became a pupil with Messrs. Easton and Anderson of Erith ironworks. Under that firm he had experience on the sewerage of Doncaster and the erection of pumping machinery on the Clyde, and in 1875 went to Russia to instal similar plant at the Cronstadt graving docks. He was afterwards employed by the Russian Government on works at Riga and Odessa, and on his return to Ireland took part in important drainage works on the Shannon.

In 1884 FitzGerald was appointed to the chair of engineering in Queen's College, Belfast, a post which he filled with conspicuous success for twenty-six years. He endeared himself to a long succession of students by his most lovable character and striking individuality as a thinker and teacher. His pleasant voice with its slight touch of southern brogue, his keen sense of humour, and his zest in handling mathematical problems, gave his teaching a constant charm, increasing as the course advanced. The gentle, happy manner in which he put at their service his great natural and acquired abilities

made an unforgettable impression on those who knew him as a teacher and a friend. No pains were too much for him in training men for the arduous career of an engineer, and his guidance and help were freely extended to them after they had graduated. Poverty in material equipment was the lot of all engineering schools until recent times, but FitzGerald had the gift of making improvised models serve the purposes for which expensive apparatus is now widely available.

Before his retirement in 1910, largely due to the stress and strain of his constant but always unobtrusive work in Belfast, FitzGerald had the joy of framing the main lines of a modern engineering school with laboratories in the reconstituted Queen's University. His services were always freely given for the furtherance of the best interests of Belfast and its University. He co-operated heartily with the civic authorities in the foundation and development of their great technical institute, which is most happily linked with the University, and his advice was much appreciated. He took, as Fleeming Jenkin did, an active and potent interest in the improvement of the status and methods of craftsmen employed in plumbing and drainage. This was work of a kind

dear to his heart, as he loved the workman, and longed to bring all good knowledge to his aid. He was an indefatigable worker, and filled in any free periods by the pursuit and criticism of questions of the higher mathematics and the subtle riddles of philosophy. He was, moreover, an excellent classical scholar.

His brother George and he had very acute and analytical minds and foreshadowed, if they did not reveal, some of the important discoveries and now accepted theories which have made later students famous. Withal FitzGerald was one of the most modest and unselfish of men, caring not at all for credit so long as good results were secured. His main work was that of a teacher, but some papers by him on rotating discs, whirling shafts, and other abstruse subjects were published in the proceedings of scientific societies. He prepared, after barometric observations over long trails on the Mourne Mountains, an interesting map of their contours.

In 1893 he married Annie Maria Charnock. Their only child, William, joined the Royal Flying Corps early in the War and was killed on service in France. To know Maurice FitzGerald was to gain an added faith in humanity.

News and Views.

THE Colonial Office Conference at its meeting on May 27 adopted the Report of Committee A on Colonial Scientific and Research Services. The committee restricted its inquiry to the three major groups of applied science affecting the non-self-governing Dependencies—namely, medicine, agriculture with its auxiliary branches, and veterinary science and forestry. Since, however, in most of these territories agriculture, including stock-raising, is the principal occupation of the populations, the committee has dealt chiefly in its report with the organisation of the agricultural services. It recommends the constitution of a central council with a chairman appointed by the Secretary of State for the Colonies (who should be a layman), a director (who should be a scientific worker of standing), and a deputy-director (with Colonial administrative experience). The functions of the council should be to make recommendations to the Secretary of State in regard to the broad lines of research programmes, the establishment and maintenance of a chain of Imperial research stations, the creation of a clearing-house of information, the organisation of a pool of scientific workers, and the organisation and general principles of administration of a Colonial Agricultural Research Service. Liaison is to be established and maintained with the Empire Marketing Board, the Medical Research Council, and any other body already existing or set up for the prosecution and encouragement of research of importance to the Dependencies. Although the committee recommends the immediate establishment of distinct services for medical, agricultural, and forestry research, and so on, the possibility of their eventual fusion into one common research service is

not discounted. In the formation of the Colonial Agricultural Research Service the committee states that the following condition should be fulfilled: it must be well paid, the members of the service should be liable to transfer, but an officer entering the service must be safeguarded against any loss on transfer.

THE annual report for 1926 of the Imperial Institute shows the progress that has been made since the passing of the Imperial Institute Act of 1925, under the administration of the new Director, Lieut.-General Sir William Furse. The Institute is divided into two departments, dealing respectively with plant and animal products, and with mineral resources. The former, which has seven committees and is under the chairmanship of Sir David Prain, appears the more active; it has during the past year answered 920 inquiries on subjects, of which a selection are mentioned in the report; they include the prevention by planting of the migration of sand dunes in Somaliland, the utilisation of locusts for the manufacture of oil, the machinery for oil palm, and inquiries as to many vegetable products. The Mineral Resources Department during the year has answered 430 inquiries, and has a list of 16 committees. The most active development during the year has been the rearrangement of the exhibition galleries on modern museum lines, aided by contributions from seventeen out of the forty-four British Dominions and Colonies. The reserve material is being removed to store and sample rooms, where it will be readily available for examination by experts. The galleries are being devoted to exhibits of popular interest with many attractive dioramas and transparencies. An Empire Art Gallery offers to exhibit gratuitously

the works of artists from any part of the British Empire. The plan is to make the galleries 'a permanent Wembley' to arouse interest in the Empire and serve as demonstration galleries in connexion with the teaching of geography in London schools. The educational work is being aided by the grant of £6000 from the Empire Marketing Board for the equipment of a cinema, and £1000 a year for five years for its maintenance.

THE financial statement for the year shows that the Imperial Institute has an income of £43,600, of which £33,500 is required for the expenses of the staff, and £1245 for publications. The popular exhibition of material and the development of the Institute to supplement the geographical classes in London schools will not by themselves fulfil the purpose of the Institute and are not likely to secure the permanent financial support of the Dominions and Colonies. They at present contribute £21,000 a year. The statement, however, that the Mineral Resources Department is to publish reports on its investigations shows that the Institute is preparing to improve its service as an information bureau for the Empire by undertaking further investigations on the natural products of our overseas Dominions and Colonies. The permanent success of the Institute will largely depend upon this side of its work. It is discouraging to hear that, in spite of the vast size of the Imperial Institute buildings, the lack of storage space renders necessary the sacrifice of specimens, and that, as regards the Library, "unless further accommodation is provided, much valuable reference material may have to be destroyed, which would considerably affect the efficiency of the two technical departments."

THE annual meeting of the British Science Guild was held on May 26, Lord Askwith occupying the chair. The report presented by Sir Richard Gregory, chairman of the Executive Committee, described the varied work of the Guild, special reference being made to the Supplement, published during the year, to the Catalogue of British Scientific and Technical Works. The Supplement was compiled by Miss D. Shaw from the lists published monthly in *NATURE*, and its publication was aided by the Carnegie United Kingdom Trust. Sir Richard Gregory admitted the disadvantages of keeping the Catalogue up-to-date by means of annual supplements, and stated that no more supplements would be published, though the issue of a new volume might be undertaken by the Guild later. The report included the text of a leaflet prepared by the Guild's Health Committee on the important question of the medical certification of the fact of death and on the signs of death, in which three simple tests of the fact of death are described. The Guild has been fortunate in securing Sir Alfred Mond as its president in succession to Lord Askwith, whose term of office has expired. Sir Alfred Mond possesses an unusual combination of qualifications for his new work. His name is known and honoured in science, politics, and industry, and his recent achievement in forming the great chemical combine known as Imperial Chemical Industries, Ltd., must con-

tribute, directly and indirectly, to the advancement of pure and applied scientific research. But perhaps his most valuable qualification is possession of the "Yes" complex, to use his own expression, a qualification valuable in any president of a society, but especially in one with such an ambitious programme of work as the British Science Guild.

THE twelfth lecture of the series "Physics in Industry," arranged by the Institute of Physics, was given on May 25 in the rooms of the Institution of Civil Engineers, by Prof. W. E. S. Turner, professor of glass technology in the University of Sheffield. The subject was "Physics in the Glass Industry." Prof. Turner said that although individual scientific workers, among them Faraday, investigated the properties of glass, the subject received little attention in scientific institutions until very recent years. He referred to the research initiated in industrial laboratories on the processes of glass-making and on the properties of the material, and to the impetus which the War gave to these investigations, particularly on optical glass. Manufacturers have believed, and the belief is difficult to eradicate, that correct annealing depends on 'baking' the glass; but recent research on the variation of viscosity with temperature, and in particular the relationship deduced by Twyman, as well as the further investigations which followed from his observations, have shown that the rate of cooling is the important factor. These observations, and related research at the National Physical Laboratory, the University of Sheffield, and elsewhere have resulted in highly important improvements in annealing practice and economy of time in manufacture. Three of the principal physical properties of glass are providing fruitful fields of research, namely, thermal expansion, electrical conductivity, and optical properties. For example, expansion measurements as carried out at the Research Laboratories of the General Electric Company have led to improvements in the manufacture of electric lamps; while observations of the absorptive properties of glass for radiation in different parts of the spectrum have led to the introduction of special glasses for therapeutic and other purposes, for example the 'vitaglass' of Messrs. Chance Brothers.

DISCOVERIES of considerable archaeological and historical importance have been made by M. F. Bisson de la Roque on behalf of the Louvre, while working under M. Georges Foucart, Director of the French Institute of Oriental Archaeology, at the Temple of Madamud near Luxor. In 1925, a temple of the Twelfth Dynasty was found underneath the Greco-Roman temple, which lies a metre below the present surface, and statues of Senosrit III. and Senosrit II., as well as inscriptions, revealed the existence here of an important sanctuary of the Middle Empire. In 1926, four groups of statuary were discovered, figuring the local god of war, Montou, and his consort Ra Tooui, the first statues ever discovered of these deities, whose cult, lasting down to Greco-Roman times, evidently rivalled that of Ammon

Ra himself. A remarkable bas-relief figures a Roman family partaking of the annual ritual feast held at night. The operations of the current season, which are described by the Cairo correspondent of the *Times* in the issue of May 24, have been directed towards clearing the sacred enclosure around the Temple and its annexes, and have demonstrated the limits of the sacred lake.

THE sensational find of the past season's work, however, came from the Ptolemaic temple itself, where excavations of the interior have brought to light, from the relatively small areas as yet explored, a mass of stone fragments—panels, statues, pillars—used by the builders of the temple for their foundations. On these fragments, which were derived from older buildings formerly standing on the site, are inscriptions and sculptures of the Twelfth Dynasty and, of more importance, of the Thirteenth Dynasty, the first dynasty of the period between the Twelfth and Seventeenth Dynasties of which both historically and culturally practically nothing is known. Seven kings have left at Madamud evidence of their architectural activity, one of them a king hitherto unknown. It is said that the art of the Thirteenth Dynasty here revealed is very characteristic and quite distinct from that of the Twelfth Dynasty, though showing the same qualities of sobriety and elegance. The evidence to be obtained from this discovery, both now and after further exploration, will undoubtedly carry great weight in the discussion of Egyptian chronology and the length of the period which intervened between the Twelfth and Seventeenth Dynasties.

AMONG the greatest of recent earthquakes, whether measured by disturbed area or the range of its recorded oscillations, is that of Dec. 16, 1920, in the province of Kansu in north-west China. Yet even this great shock seems to have been exceeded in violence by that which occurred on the evening of May 22. According to a letter from Prof. Turner (*Times*, May 25), the first tremors reached Oxford at 10.32 P.M. (G.M.T.). From the records there and at four other observatories (Kew, Helwan, Hyderabad, and Perth in West Australia), he places the epicentre in lat. 35.8° N., long. 103.4° E., or near the western margin of the province of Kansu. That of the earthquake of Dec. 16, 1920, lay in lat. 35.8° N., long. 105.7° E. Eight days later, a strong after-shock occurred about 90 miles to the west, in lat. 35.5° N., long. 104.0° E. Earthquakes of the first magnitude are rarely repeated within the same origin except at very long intervals, say, a century or more, and it is interesting to notice the continued westerly migration of the focus, the distance between the origins of the great earthquakes of 1920 and 1927 being about 130 miles.

MANY readers of NATURE will regret to learn that Mr. John Jones, the Registrar of the Imperial College of Science and Technology (which includes the City and Guilds College), retires at the end of the current session. Mr. Jones became a member of the staff of the City and Guilds College when it was opened in

1884—it was then known as the Central Institution—and he has ever since been engaged in its administrative work. His influence on the students has been far reaching. He has taken a personal interest in their welfare; in fact, it is not too much to say that he has devoted the greater part of his life to this purpose, and not only has he followed closely the progress of each one of them in the College, but also, as secretary of the Appointments Board, he has helped many of them in their subsequent careers. His knowledge of the hundreds of students who have passed through the College is remarkable, and he has often astonished men who left many years ago by recalling forgotten incidents of their youth. He leaves the Imperial College with the good wishes of every one, and a deep appreciation of his work, ability, and personality will long remain in the minds of all who have been associated with him there.

RECENT acquisitions to the British Museum (Natural History) include the following: The Department of Zoology has acquired a large and very rare squid (*Stenoteuthis caroli*) which was washed ashore in March last at Scarborough. This is especially interesting, since the stranding of large Atlantic squids on the British coasts is relatively uncommon. Messrs. Lever Bros. have presented to the same Department a complete skull with baleen plates of a Blue Whale from one of their Scottish whaling stations. The specimen from which this skull was taken was a male 72 ft. long, and the skull itself measures 17 ft. 6 in. long by 9 ft. 3 in. wide. Among purchases for the Geological Department, the most important is a beautifully preserved skeleton of an ichthyosaur, nearly 13 ft. long, on a slab of Lias shale from Holzmaden, Württemberg. This is believed to represent a new species of the genus *Eurhinosaurus*, of which only one other example is known—the *E. longirostris* of the Stuttgart Museum. A band of rock in the Devonian of Gerolstein in the Eifel is famous for its crinoids (sea-lilies), but specimens with the stem attached are very rare; a slab bearing four stalked specimens of *Hexacrinus* with arms complete is therefore an unusual acquisition. The Department of Minerals has acquired a magnificent crystal of beryl (aquamarine) of gem quality, 13 cm. high, with a diameter of 10 cm. to 12 cm. and weighing 2505 grams (12,525 carats), from Brazil. This gem is exceptional in size and in the perfection of its crystalline development. Important financial assistance has been given by Mr. J. Spedan Lewis to a collecting expedition in Indo-China under M. Delacour and Mr. Willoughby P. Lowe. The results of this expedition are to be divided between the British Museum (Natural History) and the Paris Museum.

CHINA has been much in the public eye during the last few months: the notoriety achieved would suggest that the atmosphere is not very suitable for scientific work, so that we may congratulate those who have succeeded in producing a new scientific journal and extend a welcome to the first number of the first volume of the *Chinese Journal of Physiology* published in January last. It is to be issued quarterly by the

Chinese Physiological Society, and is edited by R. K. S. Lim, B. E. Read and Hsien Wu of Peking, and H. G. Earle of Hongkong. A number of papers deal with Chinese drugs and their pharmacology, including Chinese aconite, bastard anise, and ephedrine. R. K. S. Lim describes a method of anastomosing blood-vessels by means of aluminium couplers, and with C. T. Loo and A. C. Liu has used the method in transplanting the stomach or a gastric pouch in the dog. By showing that the transplant secretes to a meal they have demonstrated the existence of a humoral, as distinct from a nervous, mechanism of gastric secretion, thus confirming the results of Ivy and Farrell. H. Necheles describes a new method of vividiffusion, using tubes made of goldbeater's skin as dialysers: the method has been applied to show the presence of a gastric secretory stimulant in the circulating blood. All the articles in this number are in English, but articles in French or German will also be published: each paper is accompanied by an abstract in Chinese.

THE firm of Messrs. Ernest Benn, Ltd., has recently begun the issue of a series of booklets which "has the revolutionary aim of providing a reference library to the best modern thought, written by the foremost authorities, at the price of sixpence a volume." Of the titles which have so far been announced, one half relate to scientific subjects, namely, "Modern Scientific Ideas," by Sir Oliver Lodge; "The Age of the Earth," by Prof. Arthur Holmes; "The Atom," by Prof. E. N. da C. Andrade; "Chemistry," by Dr. P. E. Spielmann; "Relativity," by Prof. James Rice; "The Mind and its Workings," by Mr. C. E. M. Joad; "Psycho-Analysis," by Dr. Ernest Jones; and "Introduction to Economics," by Mr. L. C. Robbins. The first three of these have already appeared, and if they are representative of the series as a whole, Messrs. Benn are to be complimented on the provision of a very valuable addition to scientific literature of the popular kind. The subjects are treated in an interesting and easily comprehensible manner, and the scope of about 30,000 words is sufficient to give the reader a good general idea of the present state of knowledge and belief in the various departments of science. Sir Oliver Lodge's contribution is described as "the expanded substance of six talks on 'Atoms and Worlds,' broadcast in October and November 1926." It therefore necessarily covers in the main the same ground as Prof. Andrade's book, and it is of considerable interest to note the varying manner of treatment of the same material by two decidedly individualistic writers.

A free public lecture on "The Eclipse of the Sun" is to be given at the East London College on Tuesday, June 14, at 5 o'clock, by Sir Frank Dyson, Astronomer Royal.

THE University of California has conferred the degree of doctor of laws upon Prof. H. H. Turner, Savilian professor of astronomy in the University of Oxford.

At the annual general meeting of the Linnean Society of New South Wales, Prof. L. Harrison, No. 3005, VOL. 119]

Challis professor of zoology in the University of Sydney, was elected president for the present session.

Mr. H. J. PAGE has resigned his position as chief chemist and head of the Chemical Department at the Rothamsted Experimental Station on his appointment as head of the Research Laboratories of Nitram, Ltd.

At the tenth annual general meeting of the Society of Glass Technology, held in Sheffield on Wednesday, April 27, Mr. W. Butterworth was re-elected president and the following officers were elected to fill vacancies: *Ordinary Members of Council*, Mr. J. D. Cauwood, Mr. F. Graves Clark, Miss V. Dimbleby, Mr. G. V. Evers, and Mr. W. W. Warren. *Honorary Secretary*, Prof. W. E. S. Turner.

IN connexion with the meeting at Essen on June 7-19 of the Association of German Chemists (Verein Deutscher Chemiker) "Achema" (Ausstellung für chemisches Apparate-Wesen) is arranging an exhibition of chemical apparatus and appliances. The exhibition will be held in the exhibition ground in the Norbertstrasse at Essen. The offices of the "Achema" are at Seelze, Hannover, to which all communications should be addressed.

DONATIONS amounting to £250 were received by the Committee formed to found a memorial to the late Mr. F. S. Spiers, secretary of the Faraday Society and the Institute of Physics. The interest on this fund is to be available for the payment of an honorarium to a lecturer on some subject in physical chemistry, the lecture to be given once in three years and to be called the Spiers Lecture. The Faraday Society has undertaken the administration of the fund for this purpose.

THE twenty-eighth annual meeting of the American Roentgen Ray Society will be held in Montreal on Sept. 20-23, under the presidency of Dr. A. Howard Pirie, of Montreal. This is the first occasion on which the Society has met outside the United States; and, to acknowledge the honour paid to a British radiologist by his election to the presidency of the Society, a party of radiologists from Great Britain is proceeding to Montreal in September to take part in the proceedings. Dr. G. W. C. Kaye has been invited by the Society to give the Caldwell lecture.

SOME details of an exploring expedition now at work in New Guinea are contained in the *Geographical Journal* for May. The expedition, which is under government auspices, is led by Mr. C. H. Karius, and left Port Moresby for the Fly River some four months ago. The Fly was to be ascended to Lario Bank by boat, where the party were to cross overland, east of the swamps, through unexplored country to the head waters of the Fly at Palmer River and the Sepik River. Thence Mr. Karius hopes to strike across the Victor Emmanuel Range and reach the Sepik lower down and follow it to Marienburg near the mouth.

THE history of science quarterly, *Archivio di Storia della Scienza*, directed by Prof. Aldo Mieli and published at Rome by the Casa Editrice Leonardo da

Vinci (Roma, 40; Via Casalmoferrato, 29), has hitherto contained articles mainly by Italian scholars. In order to render its character more international and to widen its sphere of influence, honorary editorial representatives of other nationalities have been appointed to further the cause of the journal in their respective countries. The editor for England is Mr. E. J. Holmyard (Clifton College, Bristol), who will be pleased to receive articles for publication in the *Archivio* and also to supply any information as to rates of subscription, etc. Books for review in the *Archivio* may be sent to him, or direct to Prof. Mieli, c/o the publishers, at the above address.

AN appreciation of William Bateson by an anonymous writer (*Jour. of Heredity*, vol. 17, No. 12) gives a short account of his life and work, showing that by his death the whole scientific world suffered an irreparable loss. A photograph of Merton House, Grantchester, where he lived eleven years, is given, as well as Rupert Brooke's exquisite poem on the old vicarage. It was here that the phenomenon of coupling and repulsion was discovered in sweet peas; here also that the inheritance of the various types of combs in fowls was investigated; and that "Mendel's Principles of Heredity" was written. As the exponent of discontinuity in biology and the founder of genetics, Bateson's place is secure in the history of biology, while his personal qualities will long be an inspiration to those who knew him. The article concludes with a list of his chief published papers.

A REVIEWER in NATURE of May 21, p. 739, referred appreciatively to Bragg's crystal structure discoveries, and mentioned Sir William Bragg's name alone. The reference should, however, have been to both son and father, for both were jointly concerned with the notable work on crystal structure. Indeed, Sir William Bragg says in the preface of the joint book on "X-rays and Crystal Structure" by Prof. W. L. Bragg and himself, published in 1915: "I am anxious to make one point clear, viz. that my son is responsible for the 'reflection' idea which has made it possible to advance, as well as for much the greater portion of the work of unravelling crystal structure to which the advance has led."

A BOOKLET entitled "The Production and Distribution of Clean Milk" has been prepared by Mr. A. T. R. Mattick (*The Dairyman, Ltd.*, 43 Great Tower St., E.C. 2s. net), dealing with the essential factors for the production of clean milk. It is profusely illustrated and gives much useful information. Clean milk is of importance not only to the consumer but also to the producer, for clean milk is milk with improved keeping qualities, and much monetary loss (estimated at £425,000 per annum) falls upon the producers in Great Britain owing to souring before delivery.

"WHY Everybody should assist in fighting Disease in the Tropics" is the title of a pamphlet issued by the Ladies' Committee of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, appealing to members of the public to become

associates of the Institute (minimum annual subscription, 10s. 6d.). It is hoped in this manner to obtain the funds necessary for maintenance purposes, so that other donations may be placed to the endowment fund. Mr. John Masefield contributes a forceful foreword on the value of research in tropical diseases and of Sir Ronald Ross's contributions to the subject.

UNDER the title "Modern Fruit Tree Spraying and what it Costs," the Ministry of Agriculture has recently issued an illustrated brochure, by Mr. J. Turnbull, useful to fruit-growers. It is issued as Miscellaneous Publications, No. 58, and is obtainable at the office of the Ministry, 10 Whitehall Place, London, S.W.1, price 6d. post free. The pamphlet is written to meet the difficulties that growers often encounter in their spraying operations and are nearly always due to inattention to some detail the importance of which is frequently not realised. The grower can be confidently recommended to consult this publication for information respecting the type of spraying plant best adapted to his needs and the relative costs of operation in each case.

MESSRS. G. CUSSONS, Ltd., of the Technical Works, Manchester, have sent us a copy of their folder of illustrations showing types of apparatus and equipment suitable for use in technical schools and colleges. The excellence of Messrs. Cussons' models is widely appreciated, and in this pamphlet will be found particulars of apparatus for teaching dynamics, building construction, hydraulics, steam, electricity and solid geometry. Among, perhaps, the most interesting of the appliances illustrated are the model for explaining the winding of armatures, the experimental air channel and fan-testing apparatus, and a complete hydraulic plant, including an electrically driven centrifugal pump, reservoir, Pelton wheel, Thomson turbine, weir tank, sump and Pitot tube. Many of the pieces of apparatus are designed especially for laboratories where wall space is limited or where portable apparatus is desirable.

MESSRS. GALLINKAMP's catalogue of general and industrial apparatus (19 Sun Street, Finsbury Square, E.C.2) has been very greatly expanded to meet the multifarious demands of scientific workers not only in pure chemistry but also in the cognate sciences and in various branches of technology. Thus, in the eighth edition, in addition to the ordinary equipment of furniture and apparatus used in educational laboratories, ample provision is made for the consultant and for the research worker in every department of chemistry, and also for the study of such special kinds of work as the testing of coal, cement, asphalt, petroleum, soils, milk, sugar, beer, wines, spirits, vinegar, and textiles. Mechanical apparatus offered for sale includes petrol-gas generators, high vacuum pumps, and centrifugal machines of various types, and amongst the electrical equipment we find drying-ovens, furnaces, motors, and commutating rectifiers. There is also a wide choice of optical apparatus such as microscopes, spectrometers, quartz

spectrographs, polarimeters, refractometers, projection lanterns, and epidiascopes, whilst the botanist will find a lengthy list of fresh and preserved material, together with microtomes and other essential apparatus. A valuable feature of the book is the inclusion of a mass of useful information interspersed at intervals, much of the apparatus being not only clearly depicted but somewhat minutely described. Thus there is a general description of the electrometric apparatus used for determining hydrogen-ion concentrations, together with details for its use and for the preparation of the electrodes. Similarly, anemometers for measuring the speed of draughts in flues, viscometers, electric furnaces, pyrometers, and also the automatic recording balance for studying the sedimentation and flocculation of soils, are well described. At the end there is a long list of text-books and works of reference, classified according to subjects, and 46 pages are devoted to chemicals and reagents—products of the British Drug Houses, Ltd. The volume is attractively bound and well illustrated.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant in the medical unit of the Welsh National School of Medicine—The Secretary, University College, Cardiff (June 15). A lecturer in painters' oils, colours, and varnishes at the L.C.C. Hackney Institute, Dalston Lane, E.8—The Education Officer (T.I.a.), The County Hall, Westminster Bridge, S.E.1 (June 15). A Government Inspector of Mines,

Tanganyika Territory—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (June 18). An assistant lecturer in physics in the University of Sheffield—The Registrar, University, Sheffield (June 18). Junior assistants in the electricity and engineering departments of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (June 18). Visiting instructors at the L.C.C. School of Engineering and Navigation, Poplar, for the following subjects: carpentry and joinery, acetylene welding, electrical installation work, engineering workshop practice, and engineering economics—The Education Officer (T.I.a.), The County Hall, Westminster Bridge, S.E.1 (June 20). A demonstrator of physics at St. Bartholomew's Medical College—The Dean of the College, E.C.1 (June 23). A junior technical officer for the Air Ministry Technical Development Staff, to assist in development work in connexion with aeronautical instruments and small precision apparatus, with special reference to problems relating to high altitude flying—The Chief Superintendent, R.A.E., South Farnborough, Hants (June 25, quoting A.158). A head of the textile department of the Harris Institute, Preston—The Principal and Secretary, Harris Institute, Preston (June 30). A demonstrator in the department of mechanical engineering and motive power of the City and Guilds (Engineering) College—Prof. W. E. Dalby, City and Guilds (Engineering) College, Exhibition Road, S.W.7.

Our Astronomical Column.

EXPLODED WIRES.—The reports of the great American observatories in recent years make frequent mention of observations on 'exploded wires.' Those who wish for information on the nature and object of these experiments will welcome an article on the subject by Prof. H. N. Russell in the *Scientific American* for May. The wires are made of various metals or alloys and drawn out to extreme thinness. A powerful current from a condenser charged up to about 40,000 volts is then passed through them, instantly reducing them to gas. The spectra of this gas at its various stages of cooling are then photographed with the aid of a rapidly revolving mirror, the whole phenomenon lasting about 1/25,000 of a second.

From the initial brightness it is estimated that temperatures of 20,000° C. are attained. The vapour at this time is far hotter and brighter than the solar photosphere, and approximates closely to the photospheres of the hottest stars. It has been proved that when hottest and least expanded, the column of glowing gas is opaque, and gives a continuous spectrum. It is at that time a good conductor of electricity, which is given as an explanation of its opacity. A bright-line spectrum from an electric spark shows up when placed in front of the exploded wire, but is invisible behind it. On the other hand, as the gas of the exploded wire cools, the continuous spectrum weakens and disappears, and the bright lines due to the incandescent gas appear.

The two stages correspond to the spectra of the solar photosphere (hot and opaque) and of the reversing layer (cooler and transparent). It is possible to get both spectra at once by placing the wire to be

exploded inside a wooden groove, thus retarding the expansion of the gas. The cooler gas in the outer part of the groove acts as the transparent reversing layer; the hotter gas within acts as the photosphere, and the familiar Fraunhofer lines are seen.

The changes in the spectrum of the exploded wire are similar to those in a nova, and show that the phenomena exhibited by the latter are due to the rapid expansion of the gases at its surface owing to abnormal heating from some unknown cause. These experiments have probably produced the highest temperatures and the closest approach to photospheric conditions that have yet been attained on earth.

THE POSITION OF THE AXIS OF MARS.—There are now three determinations of the position of this axis that have some claim to precision: (1) Lowell, from the polar cap; (2) W. H. Pickering, from other markings on the disc; (3) Struve, from the satellites. The question has been brought before the superintendent of the American Ephemeris, Prof. W. S. Eichelberger, as the computations for physical observations of the planets are made in that office. He has taken the opinion of several astronomers and has himself revised Struve's work of 1911, using observations up to 1924. His revision indicates that Struve's position accords well with recent observations, and further, he notes that a recent revision by Prof. W. H. Pickering gives a result much nearer Struve's position than his published result. On these grounds he has decided to use Struve's position in the American Ephemeris (and the other almanacs that use its data), beginning with the year 1931.

Research Items.

GYPSY LINGUISTICS.—In vol. 5, No. 4, of the *Journal of the Gypsy Lore Society*, Prof. R. L. Turner, by his ingenious application of methods of analysis to ascertain the position of Romani in Indo-Aryan, is able to offer suggestions as to the probable date, place, and line of departure of the gypsy exodus from India. An initial criticism disposes of the theories which assign Romani an affinity with the Dard group and that of its opponents who connect it with languages now farther in India, such as Western Pahari. The failure of both schools is due, according to Prof. Turner, first to comparison of Romani with a dialect group as it exists to-day, and secondly to neglect of the differences of value in the principles of conservation and innovation as evidence for determining dialectal connexions. Taking the early isoglosses in primitive Aryan, the middle Indo-Aryan of the Asokan edicts, Pali and the literary Prakrits, and the modern languages, the argument from the innovations points to an agreement between Romani and the central group and a difference from the north-west. Romani therefore belonged originally to the central group which now comprises Rajasthani Hindi, central and eastern Pahari, and perhaps Behari. Turning to conservations, Romani has preserved sounds which were radically modified in the central group after the gypsies had passed to the north-west, possibly about 250 A.D. Later innovations which arose in the north-west during the stay of the gypsies with that group appear in Romani, as might be expected. The argument is further borne out by an examination of both vocabulary and morphology. It is, however, by no means certain that the gypsies entered Persia speaking a single language, as Dr. Sampson maintains. There are striking differences of morphology and vocabulary between European, Armenian, and Syrian Romani, while many of the resemblances might be referred back to a common Indian origin rather than a post-Indian period of community. Yet even if at the time they emerged from the Hindu Kush they were already separated by certain isoglosses, it is reasonable to suppose they preserved contact and exerted a certain amount of mutual linguistic influence.

GAS STORAGE OF FRUIT.—The Department of Scientific and Industrial Research, Food Investigation Section, has just published Special Report No. 30 (London: H.M. Stationery Office, 1927. 1s. 9d. net), on gas storage of fruit, the research in connexion with which has been carried on by Messrs. Franklin Kidd, Cyril West, and M. N. Kidd. Their investigation, though still in the pioneer stages, may have considerable commercial importance. They have explored methods of extending the storage life of living fruit and vegetables, and retarding their natural senescent changes. Live fruits and vegetables in storage continue their process of respiration, and it seems possible by controlling the supply of oxygen and carbon dioxide to regulate the speed of the living machine as it travels through its normal course of growth and senescence. The method used was to store apples in a gas-tight chamber, the composition of the atmosphere of which could be regulated and varied by means of flues, and then to note the speed of ripening and compare the condition of the fruit with that of material stored in the ordinary way. In general, the authors' results show that within certain limits the rate of ripening of fruit after gathering is directly related to the amount of oxygen, and inversely to the amount of carbon dioxide present in the atmosphere in which it is stored. At the ordinary temperatures which obtain onwards from

September through winter and spring, it was found that atmospheres containing about 10 per cent. of carbon dioxide, with an equivalent reduction in the amount of oxygen to about half its normal value, were the most effective. At lower temperatures the effectiveness of the method decreases, just as it does at higher temperatures. At ordinary temperatures the storage life of apples may be approximately doubled in length. Experimental evidence is also given to show that reduced concentrations of oxygen and accumulations of carbon dioxide actually depress respiratory activity in the apple, and this depression is approximately proportional to the increase in length of the storage life of the fruit.

GREEN MANURING.—A booklet has been issued (London: Ernest Benn, Ltd., 1927) containing the papers contributed to the third Rothamsted Conference. These conferences are attended by persons of practical experience in the special subject under consideration from widely varying localities, and their views carry much weight. The third conference dealt with green manuring, a practice already important in the tropics, and to a less extent in other parts of the world, but in England less widely employed at present owing to severe economic and climatic limitations. The use of green manuring is to build up fertility and augment the water-holding capacity of the soil, or to maintain a rich soil in good condition. Its importance therefore to the farmer naturally varies according to the supply and cost of farmyard manure. The general view of the speakers indicates that under favourable conditions green manuring can be used in Great Britain with considerable benefit to the succeeding crop, but that the practical difficulties are often very great; e.g. risks of drought or disease in the succeeding crop may be incurred, and the establishment of the catch crop is not always easy. Mustard fallow followed by wheat is at present the most general type of green manuring practised in England, but red clover before potatoes, and lupins in the case of light land, may be useful. Finally, emphasis is laid on the necessity for a study of local conditions, as general methods cannot as yet be recommended with safety.

SPEY SALMON.—In a report on the salmon investigations on the River Spey in 1923 (*Fisheries, Scotland: Salmon Fish.*, 1926, V. (November 1926)) Mr. W. J. M. Menzies gives the results of the examination of 1763 fish caught during the months of April, May, June, July and August, in the sweep nets worked in the lowest two miles of the river's course. The majority of the fish were divided between the 1+, 2, and 2+ age groups, though of the three the 2-winters fish were slightly the most numerous. The 3-winters fish were unfortunately poorly represented owing to the lack of samples at the beginning of the season. April was mainly the spring fish month, May was a transition period between spring and summer fish, and June and July were almost wholly summer fish months. The bulk of the grilse appeared in July, and the decline in the number of grilse is again illustrated, occurring as it does in most Scottish rivers. 4.1 per cent. of the whole catch were previously spawned fish, and of these 72 salmon, only 2 had spawned twice. 66 per cent. of the smolts migrated after 2 years of river life and 33 per cent. after 3 years. The correlation between parr length at first year and age at smolt migration is again noticeable, the smaller parr at the end of the first year becoming 3-year smolts and the larger parr becoming 2-year smolts. This correlation appears to

be continued also in the sea life. The zone of rapid growth on the scales begins to appear at the end of April, and growth increases in rapidity as the summer advances. The curious checks in this summer growth that have been previously noted appear again, in the 1+ group in July and in the 2+ group nearly a month earlier.

GENETICS OF LEBISTES.—The little cyprinodont fish, *Lebistes reticulatus*, has now been used for some years in genetical experiments and has consistently shown a type of inheritance from male to male through the Y-chromosome. Crossing over is found to occur regularly between the X- and Y-chromosomes in males and between X- and X-chromosomes in females. As the result of extensive experiments, Winge (*Jour. Genetics*, vol. 18, No. 1) describes the inheritance of eighteen genes for colour markings in the males, the females being normally dull grey throughout. He has obtained forms with fresh colour patterns from the West Indies and elsewhere, and believes that a large number of such colour varieties exist. Each pattern involves the presence of certain red, yellow, or black spots, accompanied in some cases by changes in the shape of the caudal fin. Nine of the patterns here described are new, and two previous patterns are shown by crossing over to be compound. Of the whole number, nine are located in the Y-chromosome and three in the X-chromosome. Five of these have shown crossing over. A single gene, causing stripes on the body, is not sex-linked but is located in an autosome. It must be said that the patterns, which are carefully recorded in coloured plates, sometimes show a range of variation which may be due to their compound character. Dr. Winge emphasises the view that since, in *Lebistes*, crossing over occurs freely between the Y- and the X-chromosomes, a single dominant factor for maleness must be present in the Y-chromosome, and this must also presumably cross over, thereby transforming the Y- into an X-chromosome, or vice versa. Certain sex intergrades are also described.

EMBRYOLOGICAL STUDIES AND TISSUE CULTURE.—The Year-Book of the Carnegie Institution of Washington for 1925–26 contains reports of work done in the Department of Embryology. Young human embryos in the stages with 2 to 16 pairs of somites have been carefully investigated and monographed by Drs. G. W. Bartelmez and H. M. Evans, and a description of a still earlier human ovum has been published with coloured photomicrographs. Among numerous investigations of the blood and nervous systems may be mentioned the observation by Mrs. M. R. Lewis and Dr. H. B. Andervont, through tissue culture, that the sarcomatous tumours of chickens are composed chiefly of hypertrophied white blood corpuscles. They suggest that an irritant substance produced in the blood plasma stimulates these cells to abnormal activity; and they were able to transfer the tumour from chicken to chicken through either the blood plasma or the white cells. Rat tumours were similarly found to consist of an epithelioid modification of the mononuclear blood-cell, such cells if transplanted producing a fresh tumour. Among anthropological studies may be mentioned measurements of the Rama and Sumu Indians in Nicaragua, the evolution of human teeth and the inheritance of webbed toes.

HYDROGRAPHIC SURVEYING.—In Publication No. 118 of the U.S. Coast and Geodetic Survey, Lieut.-Commander J. H. Hawley gives particulars of a wire sweep for use between two launches to locate obstructions to navigation such as isolated pinnacle

rocks, wrecks, or coral formations. The sweep wire, up to 5000 yards in length, is weighted at either end and at intervals of 100 to 300 yd., and suspended from floats by lengths of wire, equal to the depth below the surface at which it is desired to search. Tow-lines from the launches are attached to the terminal weights, and sweeping is carried out at not more than $1\frac{1}{2}$ knots. The sweep wire is made up in units of 100 feet attached to each other by a gadget which parts when the sweep wire meets an obstruction. The great length of the sweep wire and the fact that the method has been used successfully for the location of some 4000 obstructions over an area of 6000 square miles justifies the very complete details which are given of the equipment, and the methods used of plotting the swept channel. Particulars of the launches, their gear for shooting and getting in the sweep, and the method used for determining the actual depth of the sweep wire while being towed, are also included. Considerable skill must be required in handling in a moderate sea, while in rough weather any such method would be impracticable.

OCEAN CURRENTS.—The International Hydrographic Bureau at Monaco has published an article on "Ocean Currents in Relation to Oceanography, Marine Biology, Meteorology, and Hydrography" by Admiral Niblack (*Special Publication No. 19*). A study of oceanic currents by the Bureau had been suggested last autumn by a delegate from Peru, who "doubtless had in mind the sudden temporary and disastrous climatic change brought about in that country in 1923, when the Humbolt current, on the West Coast of South America, had deviated from its normal course," but the Bureau generally agreed that such a study should be left to the hydrographic departments of the maritime countries. In this popular review, Admiral Niblack discusses a number of lines along which further knowledge would be of practical value for purposes other than navigation. Answers to a number of questions upon the best available methods and instruments for attacking various outstanding problems are elicited from the readers of the review, in order "to assist in the standardisation of the methods and results of oceanographic exploration." It seems early in the life of this infant science of physical oceanography, bristling with problems which can only be attacked indirectly or must await advances in other sciences before their solution is possible, to seek standardisation of methods.

OIL PROSPECTS OF THE BATTLE RIVER AREA, ALBERTA.—The summary report of the Geological Survey of Canada for 1925, Part B, contains the results of much reconnaissance and detailed examination of the Battle River area, principally in the vicinity of the Alberta-Saskatchewan boundary. The stratigraphy is chiefly Upper Cretaceous, presenting a succession of alternately marine and non-marine deposits. Generally speaking the structures are simple, the regional dip being gentle, though at least one broad fold, the Ribstone-Blackfoot anticline, has been proved; this fold has a N.E.-S.W. strike, with dips on either flank ranging from 7 ft. to 23 ft. per mile. It is doubtful whether such a flat fold in these Cretaceous deposits would be sufficient to cause oil or gas accumulation of any magnitude, and the question can only be decided by the drill. The author of the report, Mr. G. S. Hume, is not without optimism: while he admits that predictions are hazardous, he is of the opinion (based on certain assumptions) that the fold "may offer favourable prospects for oil." Much of his optimism seems to

turn on a practical application of Munn's hydraulic theory of oil migration and accumulation. This theory, elaborated by J. L. Rich, defines the principal cause of oil and gas migration as "the movement of underground water which carried with it minute globules of oil and bubbles of gas, possibly as fast as they are formed. Accumulation results from the selective segregation of oil and gas, which on account of their buoyancy always tended to work their way upward as they are carried along and are caught and retained in anticlinal or other suitable traps." The author applies this theory to structural conditions in Alberta, pointing out that water might enter the porous Cretaceous beds of the foothills and travel eastward through the Alberta syncline, thus flushing the oil and gas eastward; this would have the effect of rendering the territory under survey at least potentially encouraging.

THE PRESERVATION OF STONE.—The first report which has been issued by the Department of Scientific and Industrial Research in connexion with the problem of stone decay makes very interesting reading (Report of the Stone Preservation Committee. Pp. iv + 33 + 4 plates. (London: H.M. Stationery Office, 1927.) 1s. 3d. net). It is of course very largely of a preliminary character, as, for example, in the part dealing with bacteriological attack, and wisely no attempt is made as to definite conclusions in dealing with so complex a problem, but Mr. Scott Russell is to be congratulated on the ingenious methods which he has developed for the study of the subject. The difficulty of preparing microscopic sections of a sound and hard piece of stone is well known, and while it is obvious that a microscopic examination of decaying surfaces is of the first importance, it is very difficult to see how this can be managed. Mr. Scott Russell, by his method of infiltration with a synthetic resin in the liquid form and converting it afterwards into the solid form, has solved this problem, and some of his photo-micrographs showing the presence of the deadly sulphate of lime crystals within the stone are of the greatest interest. He has also devised an ingenious method of determining the amount of, and kind of, porosity by impregnating the limestone with resin and then dissolving away the stone and examining microscopically the resin skeleton. Of special interest are his discussions of the weathering in London of Portland stone and the conditions existing where a soot layer has been formed. Up to a certain point the soot layer seems to have a certain preservative value, but in other cases bad rotting and decay is found behind the soot layer, and it is difficult to say to what causes these very opposite results of the formation of the layer are due. Investigations on the lines of those being pursued by Mr. Scott Russell will help us to solve very important and practical problems of this kind.

THE MECHANISM OF CYCLONES.—The issue of the *Proceedings of the Imperial Academy of Japan* for February contains an abstract of a paper by Mr. T. Kobayasi, of the Aeronautical Research Institute of the University of Tokyo, which describes an alternative theory of the constitution of cyclones to the 'polar front' theory of Bjerknes, and is to appear in full in the Report of the Institute. According to Kobayasi, the 'squall line' in a cyclone is the line along which the air that has entered the cyclone from the districts north-east of its centre comes into contact with that coming from the south-east. If there is a temperature gradient in the north-south direction, the two streams produce a discontinuity of temperature along this line. The theoretical shape

of the line agrees with the actual shape of the squall line on the weather map in many cases. In the upper atmosphere the cyclone is taken as a vortex in a stream, and lines of flow and pressure distribution curves are shown. The heights at which this is a plausible description of a cyclone are calculated from the speed and temperature gradients of a number of Japanese cyclones, and they come out from 30 to 70 per cent. greater than the height of the 'surface layer' as calculated by Dines for England.

INFLAMMABILITY OF COAL DUSTS.—One of the recent publications (Paper 31) of the Safety in Mines Research Board (London: H.M. Stationery Office, 1927. 1s. 6d. net) contains an historical survey of the laboratory methods of determining the inflammability of coal dusts and a preliminary examination of the problems involved in such an investigation. It has been shown that the relative inflammabilities of coal dusts depend on a number of factors, and several possible methods of determination are discussed. The most satisfactory method of comparing the relative inflammabilities is probably the determination of the amounts of inert dust which must be added to prevent the propagation of flame. The advantage of such a method is that the results are immediately applicable to the prevention of explosions in coal mines. Previous determinations by this method have not given results of a high order of accuracy, but it is believed that the sources of error have now been eliminated. The paper, which is the work of A. L. Godbert, serves to indicate the lines on which further research in the Board's laboratories is proceeding.

STRUCTURE OF IRON OXIDE COATINGS.—The process by which a smooth rust- and wear-resisting coating of iron oxides is produced on the surface of iron objects was described by F. S. Barff in 1877. The structure of such a coating, obtained by treating the sample of iron at about 700° with steam and then cooling in air, has been determined by R. M. Bozorth by means of X-ray analysis, using X-rays of different absorption coefficients but nearly equal wave-lengths. The results have been published in the *Journal of the American Chemical Society* for April. The coating consists of layers of ferrous oxide, magnetite, and ferric oxide, and the thicknesses of the layers are estimated to be of the order, 10^{-3} cm., 2×10^{-4} cm., and 2×10^{-5} cm., respectively.

HEAT OF SOLUTION OF SODIUM CHLORIDE.—A new type of adiabatic calorimeter, which can be used with small quantities of material to determine heats of solution over a wide range of concentration with a high degree of accuracy, is described by S. G. Lipsett, F. M. G. Johnson, and O. Maass in the April issue of the *Journal of the American Chemical Society*. The calorimeter consists of a closed silver vessel divided into two compartments. The salt and the solvent are placed in the separate compartments and mixed at the proper moment by rotating the calorimeter. A thermo-couple, which receives its heat by radiation, is employed to ascertain when the outer bath and the calorimeter are at the same temperature. The apparatus has been used to determine the surface energy of solid sodium chloride by measurement of the difference between the heat of solution of ordinary crystalline sodium chloride and that of the finely divided salt at the same concentration. A value for the surface energy of 400 ergs per sq. cm. is given, but owing to the possibility of error in the calculation of the amount of surface, this figure is only approximate.

The Wellcome Historical Medical Museum.

BY invitation of Mr. Henry S. Wellcome, a conversazione and meeting of the Royal Anthropological Institute was held at the Wellcome Historical Medical Museum on the evening of May 24. A number of members of the Prehistoric Society of East Anglia, which had held a London meeting at the Royal Anthropological Institute that afternoon, was also present. A cordial message of greeting had been cabled by Mr. Wellcome, who is at present in America, and at his request the guests were received on his behalf by Mr. H. J. E. Peake, president of the Institute, and Mrs. Peake.

A short address on the character and contents of the museum in its anthropological aspect was delivered by Prof. Elliot Smith. Prof. Elliot Smith said that the great museum that Mr. Henry S. Wellcome has created is unique. It affords a concrete demonstration of the history of man's attempts to cope with the fundamental problems of life and death. If such a collection is of interest to physicians and surgeons, it is of vital importance to anthropologists, because it deals with that particular aspect of the study of mankind which is now for the first time coming to be recognised as the central aim of all humanistic inquiry. It illuminates the motives for customs and beliefs, and provides the material for interpreting what is involved in the idea of progress; but it also suggests the explanation of superstition and intolerance.

The fundamental attribute of all living creatures is the fact that they are alive; and their essential reactions serve the purpose of preserving the life that is their distinctive property. In man these instinctive processes receive articulate expression, and to the unconscious reactions for self-preservation are added innumerable devices that are deliberately invented as rational means of preserving and adding to the vital substance. In the Wellcome Museum is displayed a vast collection of charms, amulets, and elixirs of life that have been used by people of every race and clime, and of every time from the upper palæolithic to twentieth-century London, for the purpose of self-protection. As the originally rational excuse for the efficacy of most of these givers of life was shown to be unfounded, many of them still survived in popular estimation, but being stripped of any justification for their reputation, they fall into the category of magic.

Another aspect of essentially the same process is

displayed in the practice of mummy-making, the use of relics and magic bundles, and the initiation of medicine-men. Ancient literatures contain accurate reports of the real beliefs of the people of antiquity—that the processes of mummifying the body or making an image of a king conferred upon him a new existence and a new and divine personality, which enhances his powers of conferring safety and prosperity upon every individual among his subjects. The pretence of mummification is the essence of the initiation of a medicine-man, giving him a new name and new powers of life and death; and the symbol of his powers is the magic bundle, which is either the actual mummy or the pretended relic of his predecessor. In the Wellcome Museum are the mummies, the mummified heads, the magic bundles, the graven images, the standards, and the dress of the medicine-men, the amulets, the elixirs of life, the equipment of the astrologers and alchemists, that afford concrete demonstrations of the reality of these things.

The wonderful reproductions in the museum of a chronological series of pharmacies provide a dramatic demonstration of the historical links between the magic of the past and the science of to-day.

Important as the collections of the Wellcome Historical Medical Museum are as an objective record of the history of medicine and the associated sciences, its great value lies in the fact that it affords a demonstration of (and an instrument of research into) the universal problems of human aspirations, and that Mr. Wellcome had this wider vision of its meaning is shown by the fact that he has placed an anthropologist in charge of the Museum.

A vote of thanks to Mr. Wellcome was moved by Lord Onslow and seconded by Dr. Spencer, president of the History of Medicine Section of the Royal Society of Medicine. In putting the vote to the meeting, Mr. Peake emphasised Mr. Wellcome's services to humanity, of which the Museum represented part only. He referred to his work for tropical medicine, especially at Khartoum, and his support of archaeological exploration. Starting as a history of medicine, the Museum is becoming more and more anthropological in outlook. He referred also to Mr. Wellcome's judgment, in view of this aspect of the Museum, in selecting Mr. Malcolm, a trained anthropologist, as the conservator of the Museum. In replying on behalf of Mr. Wellcome, Mr. Malcolm emphasised the desire of its founder that it should develop as a Museum devoted to research.

The Production of Pure Chromium, Manganese, and Silicon.

IN connexion with the researches on the alloys of iron at present being carried on at the National Physical Laboratory, accounts are given by F. Adcock, Dr. M. L. V. Gayler, and N. P. Tucker in a paper read recently before the Iron and Steel Institute, of the successful attempt to produce three steel-making elements in a state of high purity. It is of interest that each element is prepared by an entirely different type of process. Chromium is made electrolytically, manganese is produced by distillation, and silicon by purely chemical purification.

The chromium was prepared by the electrolysis of an aqueous solution containing 30 per cent. of pure chromic acid and 1 per cent. of sulphuric acid. Lead anodes were used with tin or steel cathodes. Three types of apparatus are described, for one of which, with a steel cathode rotating at a rate of 30 revolutions per minute, the following data are given: The temperature of the bath was 20° C., the voltage 5.2,

with an amperage of 140. The current densities at the cathode and anode were 28 amp. and 7.2 amp. per sq. dm., and the yield of chromium in 30 hours was 500 grams, with a current consumption of 8.3 ampere-hours per gram.

All the samples as deposited contained hydrogen and oxygen, the former being liberated during remelting *in vacuo*. The oxygen, which in the cathode chromium is in a form which leaves no residue on solution in acid, is converted on vacuum heating into insoluble chromium oxide (Cr_2O_3). This can be removed, however, by heating the solid metal in pure, dry hydrogen to 1500°-1600° C. (The melting point of chromium is considerably above that of iron, but has not yet been accurately determined.) After these treatments, spectroscopic examination failed to reveal any impurities.

The great hardness of electrolytically deposited chromium, 600-650 Brinell, is apparently caused by

the occluded hydrogen, the crystalline form, and possibly the oxygen. It is not possessed by metal of high purity melted or annealed at high temperatures in vacuum or hydrogen, the hardness being then so low as 70 on Brinell's scale.

Manganese of purity 99.3 per cent. may be prepared by the reduction of the oxide by aluminium if the purest available materials are used. Allmand and Campbell's process of production electrolytically from a neutral bath of ammonium and manganese sulphates is also capable of yielding small quantities of the pure metal. By distillation under a pressure of 1 mm.-2 mm. in a high frequency induction furnace at a temperature just above the melting point of the metal, manganese with total impurities less than 0.01 per cent. is readily obtained. The metal thus prepared is silver grey in colour and very brittle. On remelting *in vacuo* the ingot produced is extensively cracked, a phenomenon associated with the critical points which are observed on cooling from fusion. The metal is hard enough to scratch glass and very brittle. When exposed to air it does not tarnish as do ordinary samples of the metal.

The melting point of the manganese has been determined in an atmosphere of hydrogen and is given as $1244 \pm 3^\circ \text{C}$. Four change points have been observed in the cooling curves at the following temperatures: 1191° , 1024° , 742° , and 682°C . The change at 742°C .

appears from the micro-structure to be associated with a change of crystal structure, though no such effect is observed in connexion with that at 682°C . One or both of these changes is accompanied with a marked change of volume.

The method finally adopted for the production of silicon of high purity is as follows: The best available sample of commercial silicon is broken up as small as possible and just covered with water. Strong hydrochloric acid is then added in small quantities at a time, and after the action has quietened down a considerable amount of hydrochloric acid and some nitric acid, and the whole is digested for 24 hours. The impurities, consisting mainly of iron and aluminium silicates and the silicides of iron, calcium, and magnesium, are dissolved. After the necessary washing and filtering the residue is placed in a platinum dish, water added, which is followed by a considerable excess of strong sulphuric acid and small amounts of hydrofluoric acid in small quantities at a time. When all apparent action has ceased, the mixture is evaporated until it fumes. When cool it is digested with water for some hours, filtered and washed. It is again treated with strong hydrochloric acid for several hours, filtered, washed, and dried in a steam oven. The product under favourable conditions contains 99.94 per cent. of silicon and possesses a structure consisting entirely of extensively twinned crystals. F. C. T.

The San Andreas Rift.

IF it were only for its connexion with the Californian earthquake of 1906, the San Andreas rift would be one of the most interesting fault-systems known. The movements that were the cause of that earthquake took place in the northern half of the rift, from San Juan on the south, with three submarine interruptions, to near Cape Mendocino on the north, a total length of about 270 miles. The rift, however, is known to extend more than 300 miles south of San Juan, as far as the desert regions of southern California.

The earthquake of 1906 directed attention to our ignorance of the course of the rift in the latter regions, and, during the past six years, the detailed mapping of the San Andreas fault and the associated fault-zone, together known as the San Andreas rift, has been carried out by Dr. L. F. Noble, of the U.S. Geological Survey. His work is not yet finished, but a report by him of unusual interest on the results already attained is published in the "Year-Book of the Carnegie Institution of Washington" (No. 25, 1925-26, pp. 415-428).

The area studied by Dr. Noble is the southern portion of the rift along the south border of the Mohave Desert and extending across the San Gabriel Mountains into Cajon Pass. The rift here runs in a south-easterly direction and appears as a continuous chain of scarps, trough-like depressions, and ridges, all of which afford clear evidence of recent movements. So straight is the line of the rift that one can see along it for 25 miles or more. Bordering this profound master-fault is a belt of roughly parallel and interlacing fractures, in some places as much as six miles wide. The characteristic features of the rift often change abruptly along its strike. Within half a mile, a scarp may give place to a ridge and the ridge to a trough, or a scarp facing one way may die out and give place to a scarp facing in the opposite direction. The features differ much in size. Some depressions are mere trenches a few feet wide and one or two feet deep. Others are as much as one hundred feet in depth and many hundreds of feet

wide. They are in all stages of modification by erosion, either still fresh or almost obliterated. As a rule, the older features are on a much larger scale than those of recent date, indicating that the earlier movements were of the greater magnitude. Some of the recent features point clearly to horizontal movements along the fault. For example, near Cajon Pass, four deep ravines that descend the steep slope of the San Bernardino Mountains on the east side of the rift are displaced abruptly at the fault-trace, each ravine appearing on the west side of the fault at a point at least 150 feet farther to the north-west.

The fault-zone bordering the great fault is a mosaic of elongated blocks, the longer axes of which are parallel to the strike of the fault. In many places the rock-masses are so shattered and different formations are so mixed together that it is impossible to map them. The dominant structure is a sort of slicing that appears to be mainly the result of horizontal shear along the San Andreas fault. Along some of the branching faults are narrow strips of steeply dipping Tertiary sediments pinched between much older crystalline rocks. One of these strips runs for a distance of twelve miles through the highest part of the San Gabriel Range, and in most places does not reach a hundred yards in width.

At but few places in the fault-zone are similar rocks to be found on both sides of the fault. In one portion fifty miles in length, the fault is bordered continuously on the south side by pre-Cambrian schists, while the rocks on the other side are Mesozoic granites and pre-Cambrian gneisses. No clearer evidence of the magnitude of the fault-displacements could be desired.

The first movement along the rift of which the date can be determined approximately occurred between late Mesozoic and early Quaternary times. The different stages of erosion exhibited by the recent, sub-recent, and older topographic features along the rift prove that faulting has taken place at intervals all through Quaternary time and that it has not yet come to an end. C. D.

University and Educational Intelligence.

CAMBRIDGE.—The following appointments have been made: Mr. F. Debenham, Gonville and Caius College, to be reader in geography; Mr. T. G. Bedford, Sidney Sussex College, to be lecturer in physics; Dr. E. McKenzie Taylor, St. John's College, to be lecturer, and Dr. H. E. Woodman, demonstrator in agricultural chemistry; Mr. T. K. W. Fair, Jesus College, to be demonstrator in agricultural physiology, and Mr. W. A. Wooster, Peterhouse, to be demonstrator in mineralogy.

K. R. H. Johnston, Sidney Sussex College, A. C. Candler, Trinity College, and G. A. Bell, St. John's College, have been elected to the Henry P. Davison scholarships at Harvard, Yale, and Princeton Universities respectively.

It is proposed to establish new lectureships in structural crystallography in the department of mineralogy and in cultural anthropology in the faculty of archaeology and anthropology. It is also proposed to build a special animal house to provide facilities for studying the metabolism of pigmented animals, a capital grant for the purpose having been offered by the Empire Marketing Board.

LONDON.—A research studentship, value £100, is being offered by Bedford College for Women to graduates of the college of not more than three years' standing. Particulars are obtainable from the Secretary.

OXFORD.—The Preamble to a form of Statute providing that women shall be eligible to any professorship, readership, or other university teachership, has been approved by Congregation.

The University Observatory is to be extended at a cost not exceeding £2750, and Prof. H. H. Turner's report on the work of the Observatory for the period May 1, 1926-Mar. 1, 1927, has been published. The various activities of the institution include the well-known seismological investigations by Prof. Turner and a research on "Trepidation," or the Fluctuation in the Solar System," by Dr. J. K. Fotheringham.

ST. ANDREWS.—Prof. H. J. Rose, professor of Latin since 1919 at Aberystwyth, has been appointed professor of Greek in the United College. Prof. Rose graduated at McGill University, Montreal, in 1904; he was appointed Rhodes Scholar from the Province of Quebec and went to Balliol College, Oxford. Prof. Rose has published volumes on "The Roman Questions of Plutarch," "Primitive Culture in Greece," and "Primitive Culture in Italy."

THE Royal Society announces that the secretaries are prepared to receive applications for the Mackinnon and Moseley Research Studentships, which are each of the annual value of £300. The appointments will, in the first instance, be for two years, but may be extended. Particulars and forms of application can be obtained from the assistant secretary of the Society, Burlington House, W.1. The completed forms must be returned by June 22 at latest.

Two vacation courses to be held during the coming August are being organised by Leplay House. One will be held in the High Pyrenees, with Aix-les-Thermes as its principal centre. The other will be 'a students' camp' in the Austrian Tyrol in Aldrans, 1700 feet above Innsbruck. The courses are open to all university lecturers, teachers, students, and others interested in geographical, historical, and social studies. Particulars may be obtained from Leplay House, 65 Belgrave Road, Westminster, S.W.1.

Calendar of Discovery and Invention.

June 5, 1838.—In the Journal of Caroline Fox, under this date is an entry describing a visit to King's College, London, to see Wheatstone's electric telegraph, which "is really being brought into service, as last week they began laying it down between London and Bristol, to cost £250 a mile. . . . Wheatstone has been giving lectures, and in fact is in the middle of a course. No ladies are admitted, unfortunately; the Bishop of London forbade it; seeing how they congregated to Lyell's, which prohibition so offended that gentleman that he resigned his professorship."

June 5, 1854.—More than seventy years ago, James Bowman Lindsay conceived the idea of signalling through water without wires, making experiments in the Tay, at Portsmouth, and elsewhere; and on June 5, 1854, he took out a patent for "a mode of transmitting telegraphic messages through and across water without submerged wires, the water being made available as the connecting and conducting medium."

June 6, 1761.—Transits of Venus across the sun's disc occurred in 1631 and 1639, 1761 and 1769, and in 1874 and 1882. That of 1631, though predicted, was unobserved, while Horrocks and Crabtree, two young English astronomers, were the sole observers of that of 1639. The transit of June 6, 1761, was the first to be observed by astronomers generally and many described it, while the transits of the last century were utilised to determine the solar parallax.

June 7, 1866.—On this day Francis Herbert Wenham, one of the early pioneers of flight, took out his patent, No. 1571, for improvements in apparatus for aerial navigation. His patent included "a novel arrangement of surfaces placed one above the other and kept in parallel planes by means of cords or rods or webs of woven fabric," this system of surfaces being arranged as a suitable structure for containing the motive power.

June 8, 1829.—The collaboration between Liebig and Wöhler was the outcome of a proposal by the latter. The two had met at a friend's house in Frankfurt, and on June 8, 1829, Wöhler wrote to Liebig from Sacrow, near Potsdam: "If you are so minded, we might, for the humour of it, undertake some chemical work together, in order that the result might be made known under our joint names. Of course, you would work in Giessen and I in Berlin, when we are agreed upon the plan, and we could communicate with each other from time to time as to its progress."

June 9, 1810.—The compound steam engine was brought into use by Woolf, who on June 9, 1810, took out a patent "for further improvements in the construction and working of steam engines." In a Woolf engine, steam was used expansively in the high-pressure cylinder and then passed direct to the low-pressure cylinder without an intermediate receiver. Woolf engines were considerably more economical than those previously used.

June 9, 1881.—One of the inventions which aroused the enthusiasm of Lord Kelvin was the improved form of secondary battery brought out by Faure. Many experiments were carried out at Glasgow, and in a letter to the *Times* on June 9, 1881, entitled "Electrical Storage of Dynamical Energy," Kelvin directed attention to the importance of the new form of accumulator.

June 10, 1717.—The "Sermo de structura florum" of Sébastien Vaillant (1669-1722) was read in Paris at the opening of the Jardin Royal de Paris, and afterwards published in Latin and French; the perusal of this thin volume is stated to have suggested his sexual system of plants to Carl Linnæus (1707-1778) ten years later.

E. C. S.

Societies and Academies.

LONDON.

Physical Society, April 8.—C. L. Fortescue : The characteristics of thermionic rectifiers. Rectifying valves working at low voltages with unsaturated electron currents are discussed. The most economic conditions are briefly dealt with; so far as the limited information with respect to the life of modern valves is concerned, it is probable that long life should be provided for.—B. L. Worsnop : The scattering of X-rays and the *J* phenomenon. Experiments have been carried out using a 'balance method' to obtain the *J* discontinuity which Barkla found with heterogeneous X-rays scattered by elements of low atomic weight; no such discontinuities have been found. Probably some condition which has not yet been published is required for its production.—Ezer Griffiths : A carbon dioxide measuring instrument based on sound velocity measurement. A quartz crystal is maintained in vibration piezo-electrically, and stationary waves are set up in the gas between the flat surface of the crystal and a movable reflector. The position of the nodes is recognised by the reaction on the quartz crystal, resulting in an increase of the current in the maintaining circuit. The distance from node to node is a measure of the composition of the gaseous mixture, assuming it is composed of two gases which do not react.

Geological Society, April 27.—F. W. Shotton : The conglomerates of the Enville Series of the Warwickshire Coalfield. The conglomerates are found at three horizons, to which, in descending order, the names of Allesley, Corley, and Arley-Exhall have previously been applied. The derived pebbles consist chiefly of dark Valentian sandstone, carboniferous limestone, and carboniferous chert. Igneous material is extremely rare. The Arley-Exhall pebbles are mainly carboniferous cherts, with less abundant limestone and Valentian sandstone; while the Corley materials are predominantly Valentian, with some chert, but limestone is very rare among them. The Valentian pebbles of the Arley-Exhall conglomerate were probably derived from the west, whereas similar material at the Corley horizon came from the east. It seems most reasonable to suppose the previous existence of Upper Valentian deposits upon the present north-to-south underground extension of the Nuneaton ridge. The limestone-pebbles of the Corley conglomerate may have come from the west or from the south-west.—F. C. Phillips : The serpentines of the Shetland Islands, and the associated rocks and minerals. The Shetland Islands consist mainly of a series of schists and paragneisses, with a strike over the greater part of the area of about north 10° east, and a steep westward dip. Around the eastern and western margins of Mainland occur patches of Old Red Sandstone sediments, and on the north an extensive development of igneous products of that age. A series of old intrusions, ranging from ultrabasic to acid, is found among the metamorphic rocks. The most basic of these earlier intrusions, chiefly developed in the northernmost islands of Unst and Fetlar, was a dunite, now almost entirely serpentinised. A constant accessory in these rocks is a chromespinel, and in places this becomes concentrated as workable deposits of chromite. The ores are of two main types: banded chromite-serpentine and lenticles of massive chromite-rock. The gabbro, succeeding on the east, is extensively altered, the original pyroxene being uraltised and the feldspar converted to a saussuritic aggregate. Later mineralogical and chemical changes have been brought about

by dynamic metamorphism and low-temperature weathering.

Linnean Society, April 28.—Hugh Scott : Narrative of an expedition to Abyssinia. The journey was undertaken to examine the insect fauna and, so far as possible, the flora of the highlands of central Abyssinia. The fauna and flora are of peculiar interest in that they are those of a large well-watered, elevated country in the heart of Africa, isolated from surrounding regions by low-lying desert or semi-desert tracts; and that they exhibit a remarkable blend of Palearctic, Ethiopian, and Oriental elements. The Expedition set out from Addis Ababa, the capital, at more than 8000 feet above sea-level, and several very different types of country, lying at elevations between 5500 and 12,000 feet, were visited. These included the primeval forest of Djem-Djem, composed mainly of giant juniper-trees; Mount Zuquála, an extinct volcano with a lake in its crater, and carrying giant heath; the plains southwards to Lake Zwai, a region of dry bush and thorn-scrub; the park-like country, forest, and heath-land of Mount Chillálo; and the Muger Valley, a great chasm more than 2000 feet deep, with precipitous sides. A curious mixture of temperate and distinctly African plants was frequently met with.—W. P. Pyecraft : Restoration of the left innominate bone of Rhodesian man. The restoration is based on the greater part of the left ilium. That portion of the ilium forming the outer wall of the 'false-pelvis' is remarkable for its great height and the quite unusual position of the greater sciatic notch. The acetabulum of the fragment is remarkably small and shallow, and the form of its articular surface is unusual. What answers to the lower segment of the horse-shoe loop in modern pelvises is splayed out backwards so as to cause the acetabulum to look backwards and downwards, instead of forwards and outwards as in modern man. The position of the ischium and pubis is markedly different from that of modern pelvises.

Society of Public Analysts, May 4.—W. R. Schoeller and C. Jahn : Investigations into the analytical chemistry of tantalum, niobium, and their mineral associates. (vii.) The precipitation of tungstic acid by tannin. (viii.) The separation of tungsten from tantalum and niobium. Small quantities of tungstic acid are quantitatively recovered from tungsten solutions containing alkali chloride by precipitation with tannin and cinchonine hydrochloride. A method of determining small amounts of tungsten in the presence of large amounts of earth acids has been based on this principle. Small amounts of earth acids in tungstic trioxide are determined by fusing the mixture with sodium hydroxide and treating the fused mass with sodium chloride solution; sodium tantalate and niobate remain undissolved.—S. G. Clarke : The separation of vanadium and tungsten. Vanadium may be determined in the presence of large amounts of tungsten by precipitation with cupferron (ammonium salt of nitroso-phenyl hydroxylamine) after treatment of the solution with hydrofluoric acid, neutralisation with ammonia, addition of hydrochloric acid, and dilution. The precipitate is separated, washed, and ignited at a low temperature, the residual vanadium pentoxide dissolved in dilute sulphuric acid, and the solution reduced with sulphur dioxide and titrated with permanganate.—J. M. Jones and T. McLachlan : The determination of moisture by the volatile solvent method. The method is satisfactory for emulsions, such as butter and margarine, and gives more consistent results than any other method for such products as jam, honey, and malt extract. The use of toluene as a solvent enables the results to be obtained

in a shorter time than when benzene or petroleum spirit is used.—F. Wokes and S. G. Willmott: A study of antimony trichloride as a possible quantitative reagent for vitamin A. The reaction is probably due to condensation, and can be retarded by dehydration of the solvent. The depth of the initial blue coloration obtained under standard conditions may be used to measure the vitamin A content of the oil. The intensity of colour is expressed in Lovibond blue units 30 seconds after mixing the solution of the oil and reagent.—B. S. Evans: New processes for the determination of certain elements in lead. The sample is dissolved in nitric acid, lead separated as sulphate, and arsenic precipitated with sodium hypophosphite and separated by shaking with benzene and filtering. Antimony is determined in the filtrate, and the arsenic in the precipitate is determined by an iodimetric method. Bismuth is determined colorimetrically with potassium iodide after separation of the lead as sulphate and chloride, and sulphur is determined gravimetrically after dissolving the metal in *aqua regia*, evaporating the solution to dryness, and dissolving the residue in dilute hydrochloric acid.

Optical Society, May 12.—M. von Rohr: Contributions to the history of English opticians in the first half of the nineteenth century (with special reference to spectacle history). Although London opticians during the eighteenth century had carried out splendid work as craftsmen, they were not very quick at adopting new ideas. This was a great drawback, especially as about 1818, Fraunhofer succeeded in raising the standard of his factory to an unrivalled height. Although Fraunhofer's innovations do not seem to have had any direct influence on English opticians, they were acknowledged by English men of science. Strenuous endeavours were made between 1826 and 1829 by Sir John Herschel and Michael Faraday to produce optical glass, and theoretical work was carried out by Airy, Coddington, and Hamilton. London opticians, however, did not derive the same amount of help from such scientific innovations as the Vienna school did from Stampfer and Prechtel, and the good fortune of securing Petzval's help gave, in 1840, the leading position in the manufacture of photographic lenses of high aperture to the Viennese firm of Voigtländer. The inventions of stereoscopy and photography presented opticians with new problems, and English amateurs were the first to understand photographs as perspectives of the depicted object. At the end of the period a well-directed optical glass factory was established in England.

Royal Meteorological Society, May 18.—Harold Jeffreys: Cyclones and the general circulation. If there were no variation of temperature with latitude, the atmosphere could rotate with the earth like a rigid body, and this would be a stable state. But increase of temperature towards the equator implies that the velocity from the west must increase with height, and in these conditions frictional interaction between different layers of the air and between the lowest layer and the ground would suffice to destroy any motion symmetrical about the earth's axis. Irregular horizontal interchange of air must therefore be developed, and this implies the known system of cyclones. One effect of the interchange would be that the normal winds at the surface must be on the whole as much easterly as westerly; the easterly prevailing winds are near the equator and the westerly ones in higher latitudes. This mechanism would give slow anticyclonic circulations near the poles, apart from possible local conditions.—George M. Meyer: Early water-mills in relation to changes in the rain-

fall of east Kent. Records of water-mills in Domesday and in mediæval law-suits show that the streams of the district were of greater volume at the end of the eleventh century than to-day, and that the decrease was rapid about 1275. Early in the fourteenth century, silt was carried down by the Gestling or North Stream, whereas now practically none is brought down by that stream or by the Stour near its mouth. Indeed, the varying discharge of the streams represents approximately the changes in the rainfall. These variations had a profound effect upon the silting up of local harbours, a point which may well affect the choice of site for any prospective new harbour.—S. Morris Bower: Report on winter thunderstorms in the British Islands from January 1 to March 31, 1926. The widespread thunderstorms about Feb. 16, 1926, which appear to have accompanied the passage of five squall lines, are specially treated. Figures showing the diurnal variation in the frequency of winter thunderstorms in 1925 and 1926 are included.

PARIS.

Academy of Sciences, April 20.—André Charrueau: A figure of equilibrium, of revolution, of a liquid mass in rotation, submitted to a Newtonian attraction between its particles and to the surface tension.—V. Dolejšek: The systematics of the X-rays.—P. Brun: The surface tension of liquid mixtures in the neighbourhood of the critical state. Studies in the critical temperatures of miscibility of liquids. Measurements of surface tensions of aqueous ethyl alcohol and isomyl alcohol.—Herszfinkel: The elements with atomic numbers 43, 61, 75, 85 and 87. Historical account of searches for these elements.—Robert Stumper: The thermal analysis of the dehydration of gypsum. The temperature of formation of calcium sulphate semihydrate is higher as the velocity of dehydration increases, but the temperature of formation of anhydrite is practically uninfluenced by this factor, at least within the limits of the velocities studied.—J. F. Durand and M. Banos: The addition of acetylene to carbon monoxide: the synthesis of quinone. Mixtures of carbon monoxide and acetylene treated with cuprous chloride in hydrochloric acid or ammonia solution gave no results, but in pyridine solution a reaction takes place from the products of which *p*-quinone was isolated.—L. Dollé: The hydrogeology of chalk.—P. Chevey: The transitory vascular networks of the spawn of *Acara tetramerus*.—J. Chaîne and J. Duvergier: The distinction between *Gadus capelanus*, *minutus* and *luscus* by their sagitta.

April 25.—Maurice Hamy: The measurement of the radial velocities of the stars.—Jean Perrin and Mlle. Choucroun: The rôle of molecular induction in activation by shock.—R. de Forcrand: Researches on the thallous carbonates. Thermochemical data for thallium carbonate.—Erhard Tornier: The properties of the prime numbers explained by the theory of probabilities.—Emile Borel: Remarks on the preceding communication.—A. Kovanko: The integration of series of totalisable functions.—Louis Barbillion: The true period of direct governors.—Haroutune Anjour: A new method for studying the movement of a solid body.—Charles Frémont: The cause of the cupel formation in the breaking of certain test pieces by traction.—P. David: Detection (in wireless telegraphy) by the valve.—Georges Balasse: The electrodeless discharge in damped waves or maintained waves. The continuous spectra of caesium and potassium.—Mme. L. François-Franck: An arrangement for biological photomicrography and kinemamicrophotography. A diagram in plan and elevation of the

proposed apparatus is given.—Emile Rousseau: The photochemical action of the mercury vapour arc on a liquid containing formaldehyde covered with olive oil.—Edmond Vellinger: The rotatory power of tartaric acid. Reply to a criticism by L. Longchambon.—Const. A. Kténas: The enclosures and endomorph lavas of Fouqué-Kaméni.—G. Nicolas: New biological observations on *Fegatella conica*.—G. Nadson: The perforating algæ, their distribution and their rôle in Nature. These perforating algæ are very widely distributed, and develop in great quantities in many seas. They perforate calcareous substances from the delicate teguments of the Bryozoa up to the hardest limestone rocks. Their action, although scarcely visible on cursory examination, is on a very large scale and has important results on the circulation of calcium on the earth's surface.—René Souèges: The embryogeny of the Leguminosæ. The development of the proembryo in *Trifolium minus*.—A. Sartory, R. Sartory, and J. Meyer: Researches on the causes of the appearance of the perithecium in *Aspergillus fumigatus*.—R. Fosse and Mlle. N. Rouchelmann: The action of pulped liver on ammonium cyanate.

CAPE TOWN.

Royal Society of South Africa, Mar. 16.—J. M. Watt and Marie G. Brandwijk: On *Xysmalobium undulatum*—a chemical and pharmacodynamical study of 'Chonga' (Bitter-wortel). This drug is used in South Africa as an intestinal and uterine sedative.—C. G. S. de Villiers: The comparative anatomy of the breast-shoulder apparatus of the three aglossal anuran genera *Xenopus*, *Pipa* and *Hymenochirus*. It is considered that *Xenopus* and the *Hymenochirus* group will prove to be more closely allied with each other than with *Pipa*, but in the absence of any developmental material of *Hymenochirus*, the mutual relationships of the Ethiopian *Aglossa* remain a matter of pure speculation.—G. A. H. Bedford: Description of three new species of Anoplura from South African mammals. The new species are named *Linognathus taurotragus* (from eland), *Linognathus gnu* (from black wildebeest or gnu), and *Linognathus ferrisi* (from blue wildebeest).—Sir Thomas Muir: Note on hyperorthogonants. Sylvester's suggested generalisation of the original conception of an orthogonant, although neglected for a generation, has, since Hadamard recalled it to notice in 1893, received considerable attention. The same does not hold in regard to a second generalisation (the hyperorthogonant) which is of quite a different type and not improbably may prove the more important of the two. Use was first made of a hyperorthogonant in a paper by Petrini in 1901.

MELBOURNE.

Royal Society of Victoria, Mar. 17.—Alfred J. Ewart and Phyllis Jarrett: Contributions to the flora of Australia (No. 33). Additions to the flora of the Northern Territory. Further examinations have been made of material collected by the senior author in Central Australia, as well as of Mr. Allan's Northern Territory collections and of material in the Tate Herbarium, Adelaide. The genus *Wycliffia* is merely a highly cleistogamic form of *Glinus Speggalli*. The paper contains 15 additions to the flora and 80 locality records.—H. M. Treloar: Variation of wind with height at Melbourne when geotropic winds are northerly. The mean change of wind with height in a particular class of Melbourne winds is considered, and close agreement shown to exist between computed and observed winds between the heights 50 m. and

800 m. Values of the eddy diffusivity for different parts of this height range are derived. In computing the theoretical wind distribution, difficulties associated with the use of the usual boundary conditions are avoided by applying certain determining conditions at a definite height, which height is found from the observations.—Alice M. Coverlid: The leaves of *Grewia polygama*. A decoction made by pouring boiling water over the leaves of this plant, which is a member of the order Liliaceæ, is used by white people throughout the Northern Territory and the north of Queensland, where it grows, as a remedy for dysentery. Examination showed nothing to which its alleged properties could be ascribed, except tannins, and these were present only to the extent of 4 per cent. of the dry weight of the leaves. The aborigines, credited with knowing any native plant of medicinal value, do not use this plant.—Arthur M. Lea: Australian Curculionidæ of the subfamily Gonipterides. The paper deals with a subfamily of Australian weevils which feed principally on eucalyptus leaves. Notes are given on synonymy, variation and distribution, and twenty species are described as new. One of the species, *Gonipterus scutellatus*, was accidentally introduced to South Africa, South America, and New Zealand, where it has become so abundant that the 'blue,' 'manna,' and other gums are threatened with destruction. The South African Government recently sent an entomologist to Australia, where he found a minute wasp that destroys its eggs, and this has been successfully introduced to South Africa.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, vol. 13, No. 3, March).—Carl Barus: Pinhole probe experiments with massive air columns. The acoustic pressures inside a conical horn were investigated. The curve showing the relation between pressure and depth in the horn is practically a straight line except at the mouth and base of the horn.—William V. Houston: The fine structure of the helium arc spectrum. A low current density was used and the discharge tube was cooled in liquid air. A compound Fabry-Perot interferometer was used for the diffuse series line $\lambda 5876$ and gold films on the simple interferometer for the sharp series line $\lambda 7065$. By these means it was shown that the helium spectrum has a triplet structure similar to that predicted by Heisenberg.—Paul S. Epstein: Two remarks on Schrödinger's quantum theory. The first relates to the relativity effect in the neutral hydrogen atom; the second deals with the theory of light quanta.—Boris Podolsky: On King's classical theory of radiation. Objections are raised that if the electron behaves as a rigid body and acquires a precession, it cannot absorb energy and maintain the frequency of precession, and also that a spinning electron moving with uniform translational velocity cannot have a precession.—H. Sponer: Absorption bands in nitrogen. The ultra-violet band system found by Birge and Hopfield in emission is a true absorption system of nitrogen.—J. C. Slater: Action of radiation and perturbations of atoms.—George B. Welch: The periodicity of photo-electric thresholds. As might be expected if the photo-electric threshold is a measure of the energy from incident radiation required to detach an outer electron, the threshold-atomic number curve is periodic with maxima for the alkali metals. The value for gold is anomalous.—L. F. Heimlich: Microsporogenesis in the cucumber.—Sophia Satina and A. F. Blakeslee: Further studies on biochemical differences between sexes in plants. Extracts of female plants are generally stronger

reducers of potassium permanganate than extracts from male plants. The results are closely parallel with those of the Manoilov reaction, but the reducing substances effective in the two cases are different. The reactions depend on quantitative rather than qualitative differences.—E. M. East: Inheritance of trimorphism in *Lythrum salicaria*. Self-sterility is not due to selective pollen-tube growth. The two kinds of pollen carry the same factors so far as trimorphism is concerned. Flower differences are conditioned by three genes, long style being recessive.—F. G. Benedict and E. G. Ritzman: (1) The fasting of large ruminants. Four steers have been subjected to fasts of 5 to 14 days. Records were obtained of changes of body-weight, amount of excreta, gaseous metabolism, and so on. The total carbon dioxide production in consecutive half-hour periods was measured in a respiration chamber. During the fast, the character of the urine changes from that of herbivora to that of omnivora and nitrogen excretion increases. Heat production (determined from the carbon dioxide production and respiratory quotient) decreases, at first rapidly and then more slowly. Metabolism depends on the previous feeding (maintenance or sub-maintenance) and is notably higher in young animals. (2) The basal metabolism of steers. The effect of the temperature of the environment is small. The metabolism reaches a steady value about 30 hours after the last feed. Respiration experiments during four consecutive half-hour standing periods and during 24-hour periods when the animal stood or laid down at will showed that posture has little effect. The true basal metabolism is 1300+calories per square metre of body surface, which is 40 per cent. greater than that of man. (3) The metabolic stimulus of food in the case of steers. Animals fasted for two days and then given a ration low in protein all showed a great increase of metabolism consequent on the ingestion of food. Any additional activity during feeding periods and 'the work of digestion' required by the movements of food masses through the intestines cannot account for the increased metabolism observed. It is suggested (after Grouven) that carbohydrates in the ruminant are fermented to form fatty acids and are wholly absorbed at this stage; these acids in the blood stimulate cell activity.—Leonell C. Strong: Studies on the effect of potassium alum-hydrochloric acid solutions on the growth and fate of neoplastic tissue. (1) Effect on a slow-growing adeno-carcinoma of the mouse. A stock of mice the females of which develop spontaneous mammary gland cancer has been produced. Potassium alum in hydrochloric acid was given in the drinking water, and it so affects the host or the tumour that the growth of the later is definitely slowed down and the host animal is able to live longer than it would if untreated. Complete regression of spontaneous tumours has been observed after combined oral administration and subcutaneous injection.—C. F. Roos: Dynamical economics. Competition, monopoly, and co-operation in general functions of demand and cost are discussed mathematically.—Edwin B. Wilson: On the proof of Sheppard's corrections.—D. V. Widder: Note on a generalisation of Taylor's series.—George D. Birkhoff: (1) A theory of matter and electricity. The theory requires the introduction of a 'substance coefficient' and an 'atomic potential' and it is claimed that it satisfies the demands of determinateness and stability.—(2) The hydrogen atom and the Balmer formula. By the use of the theory put forward in (1), a formula of the Balmer type is obtained.—G. A. Miller: Groups generated by two operators of order three whose product is of order three.

Official Publications Received.

BRITISH.

- Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1926, presented to the Annual Meeting, February 21st, 1927. Pp. 41+16. (York.)
- British Chemical Abstracts issued by the Bureau of Chemical Abstracts. Index, 1926. Pp. 430. (London: Society of Chemical Industry.)
- The Physiological Society. Session 1927-8. Rules, List of Members and Dates of Meetings. Pp. xii+32. (London.)
- Transactions of the Faraday Society. Index, Vols. 1 to 20. Pp. 55. (London and Edinburgh: Gurney and Jackson.) 18s. 6d. net; paper, 10s. 6d. net.
- Union of South Africa: Department of Agriculture. Bulletin No. 11: Cheddar Cheese-making. By Jas. F. Gow. Pp. 10. (Pretoria: Government Printing and Stationery Office.) 3d.
- Union of South Africa. Report of the South African Museum for the Year ended 31st December 1926. Pp. ii+13. (Cape Town.)
- Board of Education. Report on the Science Museum for the Year 1926. Pp. 27. (London: H.M. Stationery Office.) 1s. net.
- The University of Leeds: Department of Leather Industries. Report of the Advisory Committee on the Work of the Department during the Sessions 1924-25 and 1925-26. Pp. 8. (Leeds.)
- The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 37: The Soluble Silicate Content of Soils. By W. R. G. Atkins. Pp. 433-436. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.
- Falmouth Observatory. Meteorological Notes and Tables for the Year 1926. By Joshua Bath Phillips. Pp. 11. (Falmouth.)
- Proceedings of the Cambridge Philosophical Society. Vol. 23, Part 6, April. Pp. 617-754. (Cambridge: At the University Press.) 7s. 6d. net.
- The Physical Society. Proceedings, Vol. 39, Part 3, April 15. Pp. 171-230. (London: Fleetway Press, Ltd.) 6s. net.
- The North of Scotland College of Agriculture. Bulletin No. 32: Crane Fly Grub and the Oat Crop. By John Rennie. Pp. 14. Bulletin No. 33: Acarine Disease in Hive Bees; its Cause, Nature and Control. By John Rennie. Pp. 34+5 plates. 1s. (Aberdeen.)
- Electricity Commission. Electricity (Supply) Act, 1926. Central Scotland Electricity Scheme, 1927: Scheme prepared by the Electricity Commissioners in pursuance of Section Four of the Electricity (Supply) Act, 1926. Published by Order of the Central Electricity Board. Pp. 10+1 map. 1s. net. Supplementary Particulars. Pp. 78+4 diagrams. 2s. 6d. net. (London: H.M. Stationery Office.)
- The Journal of the Institution of Electrical Engineers. Edited by F. Rowell. Vol. 65, No. 365, May. Pp. 469-552+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.
- Forest Bulletin No. 68: Notes on the Comparative Economic Cost of Wood and Metal Sleepers in India, and Cost of Treatment. By J. H. Warr and H. Trotter. (Economy Series.) Pp. v+29+8 plates. 1.12 rupees; 3s.
- Forest Bulletin No. 70: *Hoplocerambyx spinicornis*—an important Pest of Sal. By D. J. Atkinson. (Entomology Series.) Pp. ii+24+5 plates. 15 annas; 1s. 6d. (Calcutta: Government of India Central Publication Branch.)
- Journal of the Indian Institute of Science. Vol. 9A, Part 9: Derivatives of Naphthaquinolines and Naphthoquinolines. By Charles Stanley Gibson, Kalvo Venkatakshina Hariharan, Kottiazath Narayana Menon and John Lionel Simonsen. Pp. 179-191. 12 annas. Vol. 9A, Part 10: i. Isomeric Phenylserines; ii. The Unstable Modification of α -Nitroso-camphor; iii. d-Mannitol from 'Gardenia turgida'. By M. O. Forster and Keshaviah Aswath Narain Rao. Pp. 193-207. 12 annas. (Bangalore.)
- Publications of the Dominion Astrophysical Observatory, Victoria. Vol. 3, No. 15: The Orbits of three A-type Spectroscopic Binaries. By W. E. Harper. Pp. 315-329. Vol. 3, No. 16: Two Spectroscopic Binary Orbits. By R. M. Petrie. Pp. 331-339. Vol. 3, No. 17: Two K-type Spectroscopic Binaries. By W. E. Harper. Pp. 341-348. (Victoria, B.C.)
- Publications of the South African Institute for Medical Research. No. 20: The Plague Problem in South Africa; Historical, Bacteriological and Entomological Studies. By J. Alexander Mitchell, Dr. J. H. Harvey Pirie and Dr. A. Ingram. Pp. 85-256. (Johannesburg.)
- Aeronautical Research Committee: Reports and Memoranda. No. 1062 (E. 23): Dopes and Detonation. Second Report by Prof. H. L. Callendar. Experiments made in the Air Ministry Laboratory at the Imperial College of Science, London, under the Direction of R. O. King, by Dr. E. W. J. Mardles and W. J. Stern, assisted by N. R. Fowler. (B. 4. Engines, 62.—T. 2372.) Pp. 81+5 plates. 1s. 8d. net. No. 1069 (Ae 251): On a Modification of the Chattock Gauge, Designed to Eliminate the Change of the Zero with Temperature. By W. J. Duncan. (C.1. Accessories-Instruments, 93.—T. 2368.) Pp. 5+1 plate. 6d. net. No. 1074 (Ae 256): Full Scale Tests of a Suspended Air Log. By J. K. Hardy. (C.1. Accessories-Instruments, 94.—T. 2391.) Pp. 4+1 plate. 4d. net. (London: H.M. Stationery Office.)
- The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 36: On the Index Fossil of the *Cleistopora* Zone. By Dr. Louis B. Smith. Pp. 423-431+plates 20-22. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2s. 6d.
- Bishop's Stortford College. Report of the Proceedings of the Natural History Society, 1926. Pp. 23. (Bishop's Stortford.)

FOREIGN.

- Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelungen No. 19: Monsoon-Currents in the Java Sea and its Entrances. By H. P. Berlage, Jr. Pp. 23+21 plates. (Wetlevreden: Landsdrukkerij.)
- Report of the Aeronautical Research Institute, Tokyo Imperial University. No. 20: On the Mechanism of Cyclones and Anticyclones, Part 2. By Tatuo Kobayasi. Pp. 205-233. 0.50 yen. No. 21: Lower Limit of Inflammability of Ethyl Alcohol, Ethyl Ether, Methyl Cyclohexane and their Mixtures. By Yoshio Tanaka, Yuzaburo Nagai and Kinsei Akiyama. Pp. 235-245. 0.25 yen. (Tokyo: Koseikai Publishing Office.)

United States Department of Agriculture. Department Bulletin No. 1469: The Satin Moth, a recently introduced Pest. By A. F. Burgess and S. S. Crossman. Pp. 23+1 plate. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 378: Tables for Albers Projection. By Oscar S. Adams. (Special Publication No. 130.) Pp. 11+24. (Washington, D.C.: Government Printing Office.) 5 cents.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 2: Record of Current Educational Publications, comprising Publications received by the Bureau of Education to January 1, 1927. Pp. 58. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the United States National Museum. Vol. 70, Art. 18: Small Shells from Dredgings off the Southeast Coast of the United States by the United States Fisheries Steamer *Albatross* in 1885 and 1886. By William H. Dall. (No. 2667.) Pp. 134. Vol. 70, Art. 23: A Revision of the Beetles of the Genus *Oedionychys* occurring in America north of Mexico. By Doris Holmes Blake. (No. 2672.) Pp. 44+2 plates. Vol. 71, Art. 11: Notes on the Melitaeid Butterfly *Euphydryas phlaetor* (Drury), with Descriptions of a new Subspecies and a new Variety. By Austin H. Clark. (No. 2688.) Pp. 22+5 plates. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1926. Pp. ix+205. (Washington, D.C.: Government Printing Office.) 25 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 78, 1926. Pp. 11+506+40 plates+228. (Philadelphia, Pa.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 387: Soundproofing of Apartment Houses. By V. L. Chrysler. Pp. 253-260. (Washington, D.C.: Government Printing Office.) 5 cents.

Bulletin of the American Museum of Natural History. Vol. 53, Art. 2: The Aquatic Mollusks of the Belgian Congo, with a Geographical and Ecological Account of Congo Malacology. By Henry A. Pilsbry and J. Bequaert. Pp. 69-602+plates 10-77. (New York City.)

Diary of Societies.

SATURDAY, JUNE 4.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at Town Hall, Maidstone), at 11 a.m.—T. F. Bunting: Housing in Borough of Maidstone; Widening of Maidstone Bridge, New Elementary School.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB, at 8.15.—Sir Leonard Rogers: Climate and Disease Incidence in India: Forecasting Epidemics.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish Meeting) (at Dunfermline).

MONDAY, JUNE 6.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. Harvey-Gibson: Account of the Life of De Saussure 1767-1845, with the gift of the MSS. of a Translation of his "Recherches chimiques sur la végétation," 1804.—Ethel Currie: Fossil Echinidea of Somaliland.—A. Calder: A Case of Partial Sex Transformation in Cattle.—W. O. Kermack and W. T. H. Willmanson: Stability of Suspensions, Part 2, The Rate of Sedimentation of Kaolin Suspensions containing Colloidal Silicon Dioxide.—Amy Fleming: The Peripheral Sympathetic Innervation of the Uterus (*to be read by title*).—W. L. Ferrar: Consistency of Cardinal Function Interpolation (*to be read by title*).—Prof. W. H. Lang: Contributions to the Study of the Old Red Sandstone Flora of Scotland, Part VI., On *Zosterophyllum Mytonianum*, Penh., and some other Plant Remains from the Carnyllie Beds of the Lower Old Red Sandstone. Part VII. On a Specimen of *Pseudosporochnus*, from the Stromness Beds (*to be read by title*).—Sir Thomas Muir: The Theory of Orthogonants and Latent Roots from 1881 to 1918 (*to be read by title*).

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. F. Aveling: Mental Association.

TUESDAY, JUNE 7.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. J. P. Hill: Exhibition of Lantern-slides of Echinid Embryos.—R. I. Pocock: The Gibbons of the Genus *Hylobates*.—Dr. C. A. Nilsson-Cantell: Some Barnacles in the British Museum (Natural History).—R. Gurney: Zoological Results of the Cambridge Expedition to the Suez Canal, 1924. Report on the Crustacea, Copepoda (Littoral and Semi-Parasitic).—P. Esben-Petersen: New Species of *Neuroptera Planipennia* in British Collections.—IV.

THURSDAY, JUNE 9.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections) (Summer Meeting).—Otolological Session, at 2.30.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. W. E. H. Berwick: Modular Invariants Expressed in Terms of Quadratic and Cubic Irrationalities.—H. Bohr: On the Limit Values of Analytic Functions.—Prof. E. H. Neville: The Logarithmic Singularity of the Quarter-period K .—Prof. J. Proudman and F. Edith Mercer: On the Theory of the Oscillations of a Rotating Mechanical System of Infinite Freedom.

BRITISH PSYCHOLOGICAL SOCIETY (Aesthetics Section) (at Royal Anthropological Institute), at 6.—Dr. E. D. Hutchinson: The Psychology of Creative Effort.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. T. H. Harrison: The Use of Photo-electric Cells for Precision Photometry of Electric Lamps.—R. Kingslake: An Experimental Study of the Best Medium Wave-length for Visual Achromatism.—Sushil Krishna Datta: On Brewster's Bands. Part II.

FRIDAY, JUNE 10.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections) (Summer Meeting).—Otolological Session, 10 a.m. to 12.30.—Papers on Progressive Middle-ear Deafness:—Dr. Scott Stevenson and E. Horace Richards: Preliminary Study of Chronic Middle-ear Deafness.—G. J. Jenkins: Paper.—Dr. D. McKenzie: What is Progressive Middle-ear Deafness?—Dr. A. Gray: Demonstration by Stereoscopic Transparencies of Specimens of the Temporal Bone.—Dr. D. McKenzie: Posterior (Mastoid) Drainage in Acute Suppuration of the Middle Ear.—Laryngological Clinical Meeting, at 4.—Cases and Specimens by W. S. Syme, H. Kisch, T. B. Layton, and others.

ROYAL ASTRONOMICAL SOCIETY, at 5.—B. M. Peek: Observations of Nova, 1926-27.—Dr. H. Spencer Jones: Note on the Mass of Venus deduced from Cape Helioscope Observations.—Dr. J. K. E. Halm: On a Graphical Determination of the Orbital Elements of a Spectroscopic Binary.—R. C. Johnson: Note on the Origin of Certain Radiations in Cometary Spectra.—V. A. Ambazumian and N. A. Kosiev: Radiative Equilibrium in Inner Layers of Stars.—P. A. Taylor: (a) The Equilibrium of the Calcium Chromosphere; (b) The Light-Intensity of the Calcium Chromosphere.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—J. H. Awwery: The Latent Heat of Evaporation of Sulphur.—H. Lowery: The Refraction and Dispersion of Carbon Tetrachloride.—P. K. Kichlu: Regularities in the Spectrum of Ionised Neon.—Demonstration of the Schönher-Hessburgh Nitrogen Fixation Arc, by Capt. G. J. Finch.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—C. T. Onions: The New English Dictionary.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Report of the Special Committee on Tabulating the Results of Heat Engine Trials.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Prof. H. L. Hawkins: Echinoid Illustrations of Some Problems in Evolution (Lecture).

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Department of Zoology and Comparative Anatomy, Oxford), at 8.15.—Prof. J. Barcroft: Respiratory Pigments.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. L. Woolley: The Excavations at Ur.

SATURDAY, JUNE 11.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections) (Summer Meeting).—Otolological Session (Clinical Meeting), at 10.—Dr. G. Portmann: The Sacculi Endolymphaticus and an Operation for Draining the same for the Relief of Vertigo.—Cases and Specimens by Dr. A. R. Friel, A. R. Tweedie, Dr. T. B. Jobson, N. Barnett, E. B. Barnes, and others.

PUBLIC LECTURES.

WEDNESDAY, JUNE 8.

UNIVERSITY COLLEGE, at 5.30.—Prof. Raymond Pearl: Experimental Vital Statistics. (Succeeding Lectures on June 9 and 10.)

THURSDAY, JUNE 9.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Prof. B. J. Collingwood: Molecular Movement in the Living Body.

FRIDAY, JUNE 10.

UNIVERSITY COLLEGE, at 5.30.—Prof. R. A. S. Macalister: Celtic Art. (Succeeding Lectures on June 13 and 15.)

SUNDAY, JUNE 12.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Dr. R. E. M. Wheeler: Some of the Ancient Civilisations of Britain.

CONVENTIONS.

JUNE 4 TO 7.

ANNUAL CONFERENCE OF THE ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (at Plymouth).

JUNE 6 TO 9.

CONVENTION OF CANADIAN CHEMISTS (at Quebec).

JUNE 6 TO 11.

PHOTOGRAPHIC CONVENTION OF THE UNITED KINGDOM (at Warwick).

Monday, June 6.—Afternoon.—Welcome by the Mayor of Warwick. Installation of President. Presidential Address. Annual General Meeting.

Tuesday, June 7.—Evening.—H. Baker: Lecture.

Wednesday, June 8.—Evening.—A. S. Newman: Lecture.

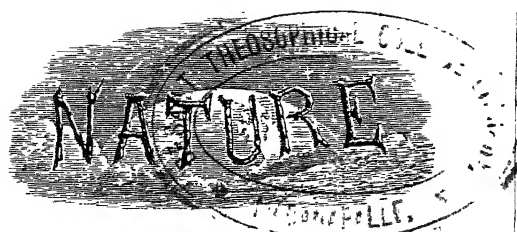
Thursday, June 9.—Evening.—A. S. Newman: Lecture.

Friday, June 10.—Evening.—A. Keighley: Lecture.

Saturday, June 11.

JUNE 16 AND 17.

CONGRESS OF INTERNAL COMBUSTION ENGINE (at Padua).



SATURDAY, JUNE 11, 1927.

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Foundations of Empire.

WE regret our inability, at the present moment, to climb to philosophical heights with Aristotle and to declare that man is a political animal, or to sink into the comfortless cynicism of Schopenhauer and to assert that human society is a collection of hedgehogs driven together for the sake of warmth. Somewhere between the two exaggerations lies truth—whatever that may be. In the meantime our function, as we conceive it, is to probe, analyse, compare, and classify phenomena in the purely agnostic spirit which is the life and hope of science. This may be regarded merely as a restatement of something already grown platitudinous, yet it may appropriately serve as a prologue to some observations upon a programme of a forthcoming imperial event.

On June 20 the inaugural meeting of the third Imperial Education Conference is to be held. It will be open neither to the public nor to the press, membership being confined to delegates appointed by the Governments of the countries composing the British Empire—usually the permanent heads of their education departments—together with representatives of certain Government departments in Great Britain. For the first time in the history of the Conference, also, a few seats have been allotted to representatives of local education authorities and the teaching profession.

We are further informed that the advisory committee responsible for the arrangements, after consulting all the Governments of the Empire, "has drawn up a comprehensive agenda which covers not only important administrative questions but also a number of subjects of general educational interest." It is hoped, particularly, that some agreement may be reached on problems arising out of the variety of teachers' qualifications, salary scales, and superannuation, since these are matters where lack of reciprocal arrangements tends to hinder the movement of teachers from one part of the Empire to another. With that aspiration we are wholly in sympathy; it needs neither explanation nor argument.

When we turn to the groups of more general educational subjects which are to be discussed, however, we feel some misgivings. There is to be a very necessary reference to education in relation to the pupil's after-career, and here special interest will be attached to the views of overseas Dominions on the recent report of the Consultative Committee of the Board of Education—a report on which we have already expressed our views (NATURE, Feb. 5). There is to be an important discussion on the

difficulties of rural education, while other sessions will be devoted to the cinema and wireless in education, physical training, adult education and the problems involved therein; and, most importantly, there stands out a group of subjects "dealing with important new ideas and developments" which appears to pivot about "Empire History and Geography."

Now it is after glancing at these suggested discussions that we would beg leave to submit our doubts as to whether sufficient advantage is to be taken of the tremendous possibilities afforded by the Conference. We do not propose to inquire here into all the implications of the word 'Empire,' but we do desire to record our belief that, if it is to signify a progressive and cultural unity, it must sum up the felicitous relations of component parts based upon the mutual benefits arising out of trade and industry.

To that end we believe a considerable part of the Conference should be devoted to an examination of the possibilities of pure and applied science. We make the suggestion because we observe that a special feature of the Conference is the leaving open of a whole session for the discussion of a subject to be chosen by the members during the second week. We have a special reason for urging that a broad discussion of the value—both cultural and practical—of science and technology in education is necessary in matters of Empire development. If we say that the functions of science include intercourse for the purpose of more efficient co-operation and economy of intellectual labour by the discovery of general laws governing typical situations, we shall not be placing anything on record for the first time. We shall, however, be repeating something to which controllers of education and directors of imperial destinies often give lip-service and very little more.

It is the very fact that science possesses a more international quality than matters which usually come under the heading of literature or philosophy which makes us press specially its claims to the Conference. If it be neglected, if it be treated merely as incidental, a structure of recommendations will be erected by the Conference on an unsound foundation. We have already doubted whether man is a willing political animal; we certainly doubt his ability to hold an Empire together by a repetition of academic theories.

The well-being and happiness of either a nation or an empire depend upon mutual production and exchange. Production and exchange—from raw material to the distribution of finished articles

—involve change and adaptation of material, power, transport, and business organisation. All these, subdivided into the various branches of knowledge, form the subjects included in curricula of technical institutions. How far is the shaping of such curricula to be a subject of discussion by the Conference? How far, in short, is science (in its broadest sense) to be dealt with with the view of producing methods which shall clear away disorders and anomalies capable of cure?

In what light, for example, will 'History' be treated? Will there be an attempt to gain for the Empire the urge and the clarity of thought which might arise from a synthesis of those events which have made British imperial development possible? How far have we clearly focussed the flow and direction of human endeavour arising out of geographical discoveries of the fifteenth century?—Magellan's circumnavigation of the earth, the cosmic system of Copernicus and other liberations of the mind of the sixteenth century, the founding of experimental science by Galileo, Gilbert, and Harvey, and the vast spread of scientific knowledge which led up, finally, in the nineteenth century to the theory of evolution—the application of which to branches of art and industry has powerfully aided the demolition of time and space, and has enabled us, with our steamboats and our railways and our telegraphs, to hold together in a developing understanding the far-spread units which make up the British Empire? The focussing of these things would, we believe, give to the Conference an impetus towards clear and rational efforts to grasp and remove the stupid barriers which so often hold back development, and to use the great instrument of education so that it shall more swiftly build up the materials of progress.

We realise that we may have laid ourselves open to the charge of waving our own particular flag of science and technology. It is not a charge we fear, since we have our own convictions concerning the liberal and cultural powers of what is often ignorantly regarded as 'merely utilitarian.' We realise, too, that we may be charged with beating the air, because all we have suggested will come within the purview of the Conference. If that be so, we shall plead guilty unblushingly. We shall freely apologise for traversing old ground even though, in making the apology, we insist that the fundamentals upon which education schemes should be built are so vital that their constant examination and repetition is not superfluous but supremely necessary.

Weather and Weather Forecasting.

Wetter und Wettervorhersage (Synoptische Meteorologie). Von Prof. Dr. Albert Defant. Zweite, vollständig umgearbeitete Auflage. Pp. vii + 346. (Leipzig und Wien: Franz Deuticke, 1926.) 18 gold marks.

THERE is an excellent arrangement in Austria under which from time to time one of the most promising of their meteorologists, after a period of official work in the State service, is appointed to the professorship of meteorology at Innsbruck, where he has leisure for the closer study of that branch of the subject in which he has become specially interested. This results not only in additions to our knowledge on the frontiers of the subject, but also in text-books which give in collective form and in logical sequence a summary of our knowledge over some sector of the meteorological circle. Notable examples are the "Meteorological Optics" of Perntner and the "Dynamical Meteorology" of Exner. The present officer at Innsbruck, Prof. Defant, adds as his contribution a book on weather and weather forecasting which is a development of a small book prepared and published originally in 1916-17.

The book is divided into three parts, corresponding with the author's general view of the subject. The first part, on weather, is devoted to a discussion of 'diagnosis'; the second part, on weather forecasting, indicates the methods to be followed in the 'prognosis.' The third part gives a summary of our knowledge of weather changes of longer period, a knowledge which has not yet reached the stage at which it can be applied for regular forecasts of months, seasons, or years in the European area.

In an initial chapter Prof. Defant indicates the development from weather rules and the weather prophet to the synoptic chart as the scientific basis of forecasting. He reproduces an interesting chart, due to Brandes, showing the distribution of pressure and wind in Europe on March 6, 1783, the first synoptic chart in meteorological history.

Detailed particulars are given of the revised International Code for Weather Telegraphy, but for some reason it is described as the 'Swedish' code, and Great Britain and Norway, where this code has been used since 1921 for international exchange, are represented as using different codes special to themselves. (There is an error on page 15, where the figure for alto-stratus is given as 4, which should have been allotted to alto-cumulus.)

The importance of wireless telegraphy in post-War developments is emphasised, and a wireless installation is stated rightly to be now an essential complement to a weather service.

There is a remark in this chapter the importance of which cannot be too often emphasised. In forecasting, and in any examination of meteorological observations by means of maps, accidental errors of observation can often be readily detected; but there are atmospheric conditions in which individual stations may show apparently irregular differences from other stations, and there is a risk that the most interesting and instructive meteorological situations may pass without investigation, owing to the observations being regarded as erroneous and 'corrected' for the errors.

In the second chapter an account is given of the connexion between wind and pressure. In the original analysis by Guldberg and Mohn, the motion of the air near the earth's surface was assumed to be steady motion with a balance between the three forces due to the pressure gradient, the effect of the earth's rotation, and the surface friction, the last named being taken to act directly opposite to the motion. Prof. Defant, following Sandstrom, shows that a better agreement with the facts is obtained if the frictional force is assumed to act in a direction which is inclined at a finite angle (38° for central Europe) to the direction of motion.

This assumption of a single frictional force, which is essentially the vector difference between the force due to surface friction and the tangential stress due to transfer of momentum by eddies, obscures the physical reality. Actually the transfer of momentum to the surface layer from the layers above is so rapid that the tangential stress due to it is large in comparison with the forces due to the pressure gradient and the earth's rotation, even for a layer of finite thickness. The motion of the surface layer is, therefore, effectively determined by the balance between surface friction and tangential stress, acting in opposite directions *along the line of motion*. The pressure gradient and the earth's rotation do not directly affect in measurable degree the surface wind, or the wind in any layer where there is a rapid rate of change of horizontal velocity with height and the motion is turbulent; they determine completely the wind in those layers where the tangential stresses are small, *i.e.* generally in layers at heights of 1000 feet or more, and they play their part in the intermediate layers where the tangential stresses are of

the same order of magnitude as themselves, layers from which the momentum to maintain the motion near the surface is transferred.

The fact that the 'mass forces' due to pressure gradient and earth's rotation can be ignored in treating the surface layers, implicit in Taylor's discussion of the subject, was stated explicitly by Whipple in 1920. No mention is made of this in the book, and there is nowhere any account of the development in our knowledge of turbulence in the last fifteen years, and its applications in all dynamical and thermodynamical studies of the atmosphere. The statement on p. 30 that but for the earth's rotation the wind would blow direct in straight lines from the places of highest pressure to those of lowest pressure needs qualification; with curved isobars there would be usually a rotatory wind system irrespective of the earth's rotation, and waterspouts and dust-devils would occur much as they do at present.

Chap. iii. deals with the motion of the air and its connexion with cloud and precipitation, and it introduces the reader to the work of Bjerknes and the idea of fronts, lines of convergence and of divergence. It is pleasant to see in this chapter reproductions of trajectories of air over the Atlantic from Shaw and Lempfert's "Life History of Surface Air Currents." The reproductions are much superior in appearance to the originals printed by the British Stationery Office. In the description of a warm front on p. 47, Ci-Cu. should be Ci.St., and it ought to be noted that in the warm sector, where normally cloud diminishes and precipitation ceases and the barometer remains nearly steady, it is not infrequent to find an overcast sky with heavy precipitation and a rapidly falling barometer. Some account could appropriately have been given in this chapter or the next of "les systèmes nuageux" and the work of Schereschewsky and Wehrle, which constitutes the contribution of French meteorologists to the recent development in forecasting.

The discussion of the relation between the weather and typical forms of the isobars is an effort to combine the old ideas of cyclones and anticyclones and the new ideas of fronts dividing masses of air of different constitutions. Fortunately the new theories have, on the whole, gained pride of place. There is a good account of the ideas of Bjerknes and Solberg on the development of cyclones and occlusions, as well as an indication of the principal results of the important research of Bergeron and Swoboda, in which developments along a front extending from mid-Atlantic to

eastern Europe in October 1923 were examined in detail and interpreted.

The fifth chapter deals with the non-periodic variations of pressure and of the motion of cyclones and anticyclones in the European area. Van Bebber's well-known diagram is reproduced, and Hanzlik's penetrating analysis of the temperature conditions in anticyclones finds here an appropriate place. The difference between the cold rapidly moving anticyclone and the warm stationary, or slow moving, anticyclone is of fundamental importance.

In the second part of the fifth chapter the author considers the constitution and origin of cyclones and anticyclones, and contrasts the wave theory of Bjerknes with the 'bar' theory of Exner. According to Bjerknes, depressions arise from waves at the sloping surface of separation between the cold polar air and the warm tropical air, and come in families, while according to Exner, depressions arise through a tongue of cold air projecting horizontally into a warm equatorial current and damming it up in such a way that vortical circulation results. Considerable space is naturally devoted to a consideration of thunderstorms and line-squalls, on which the experimental work of Schmidt on the motion of a heavy liquid spreading under a lighter one has thrown so much light; the diagnosis is, however, quite inadequate without some account of the thermodynamics of the phenomena and of the part which the condensation or evaporation of water in the atmosphere plays in causing instability.

The section on cyclones and anticyclones concludes with an account of periodic variations of weather. These are not sufficiently well established to be of much value in forecasting: the most interesting is a period between five and six days which Prof. Defant found in the general circulation of the northern hemisphere; this agrees generally with the theory of Bjerknes and Solberg on families of cyclones.

The section on weather forecasting occupies only about one-fifth of the book, the author's view being that diagnosis is the most important part of the forecaster's education. After some general remarks and a short discussion of Richardson's investigation of the method of weather prediction by numerical process, the author considers the use which can be made of local observations and statistics in forecasting, and he gives an interesting account of a method of determining the delimitation of the districts into which a country must be divided for forecast purposes. He deals

at some length with the rules of M. Guilbert and with the persistence of weather conditions. He examines in detail examples of weather charts for March 13, 1913, and June 1, 1924, and indicates how the charts are to be interpreted in the light of modern theory.

Many people appear to consider that weather forecasting is the sole purpose of meteorology; according to Prof. Defant, it stands in the same relation to meteorology in general as an applied science stands to a pure science. There are meteorologists of the purer kind who consider that weather forecasting is a combination of drudgery and humbug by means of which funds are obtained for the prosecution of work fundamental to the extension of knowledge. Such a view is based on a misconception. The desire to forecast the future course of the weather is as legitimate an impulse to the scientific investigation which is necessary for its satisfaction as the desire to understand or investigate any natural phenomenon. The two impulses—the desire to understand and the desire to foretell—are in fact the motive force in scientific investigation, and neither can be classed as better or worse than the other.

One of the principal difficulties of a forecast service is to obtain an objective test of the accuracy of forecasts. Prof. Defant indicates what progress has been made in this direction—unfortunately little. The subjective estimates of the accuracy or inaccuracy of weather forecasts formed by the public are of no real value, because a forecast covers a considerable number of phenomena and the public lays stress now on one and now on another; it is, moreover, influenced, broadly speaking, by its own optimism or pessimism. Such is Prof. Defant's view, but a good forecaster must have some understanding of the needs of the public, and must himself emphasise in his forecast the elements which will affect most those for whom the forecast is issued.

Hitherto there has been no book on weather forecasting in which the post-War developments, both in the collection of information and in its analysis, have been presented in their appropriate place as part of the whole scheme of weather forecasting. The present book is notable because it makes an endeavour to do this. Information which is scattered through many international reports and through many dissertations is here available for the reader. There are errors and gaps, but on the whole the result at which Prof. Defant aimed has been achieved successfully.

E. GOLD.

Land Politics and Economics.

Politics and the Land. By Cecil Dampier Whetham. Pp. x+215. (Cambridge: At the University Press, 1927.) 6s. net.

MR. DAMPIER WHETHAM has chosen a most opportune time for bringing out his book upon the land. It is so clearly and interestingly written that it should appeal to a wide public, to those who know little about the land as well as to those who are directly interested in the land and in agriculture.

There is no doubt that an ever-increasing number of people in Great Britain are being stirred to an interest in the land—but mainly from the political point of view. Now a purely political interest in the land can be dangerous unless it is balanced by some understanding of economics and of agriculture. The author is specially qualified to deal with the land problem precisely on account of his knowledge of economics and of agriculture from the practical side. His moderate and carefully reasoned reply to the policies (overwhelmingly political) put forward by Mr. Lloyd George and the Labour Party is admirable. Mr. Whetham shows conclusively that to resort to such drastic change (which would certainly be in the nature of experiment) as nationalising the land is not warranted, and would be fraught with danger.

It is interesting to note in this connexion that the decidedly socialistic government of Czechoslovakia, when it brought in sweeping land reforms, did not nationalise the land, but rather developed small ownership. The reason for this was given in the words of several of the leading statesmen of the country, that State ownership or nationalisation in any form could end in one thing only—the ruin of the agricultural industry.

Perhaps of even more importance than his handling of "politics and the land" is Mr. Whetham's exposition of "economics and the land." He shows how and to what extent certain economic forces affect agricultural prosperity. In simple language he goes deeply into the economic questions which it seems obvious few of the land reformers have studied or understood—and still fewer agriculturists. Yet they are questions which every agriculturist as well as every reformer should understand.

In thus ably refuting the attacks upon the existing land system in Great Britain, I feel that Mr. Whetham gives the impression that he is more satisfied with the present system than he really is; it is quite true that he points out that the system

is not perfect and could be improved, but I refer to the general impression. Mr. Whetham certainly regards the landlord-tenant system more favourably than I do. Before the great depression of the 'eighties, I concede that it was about as good a system as could be devised, but during the past forty years it has steadily become more and more unsatisfactory, especially from the landowners' point of view. It is obviously satisfactory to the tenant. Discussing this question with a frank and outspoken farmer, he summed up thus: "As long as you landowners are content to put your hands in your pockets and pay for us, pray go on doing so; when you get tired of it, see that we can purchase under sound financial conditions."

Mr. Whetham clearly does not favour the development of an increase in occupying ownership as a partial alternative to the tenancy system, and the strongest barrier against nationalisation; he fails to realise that unless occupying ownership is developed, then nationalisation of the land is inevitable. He points out that in the United States the tendency is away from ownership towards tenancy; but the farmers in the United States are, in the main, occupying owners, and the tenancy that is developing there is in no way like the British system, but rather a partnership tenancy resembling the *métayer* system in Italy and parts of France. Hand in hand with the development of occupying ownership in Great Britain might well go the creation of a system of partnership farming, but of a type very different from the *métayer*. Space does not permit me to give here a detailed account of the form of partnership farming which I advocate and have practised for nearly twenty years.

Coming to another point, the author does his best to persuade us that the yield from the corn land of Great Britain is as high or higher than any other country in Europe (except Belgium). He bases his argument largely upon the statistics of a particularly urban economist who shows that the corn yields of Denmark when 'corrected' are no higher than ours. I am interested in this 'correcting' of yields, and in future I must not believe my eyes when motoring through the Fens or Lothians, but take consolation in thinking that the very heavy corn crops one sees on every side when 'corrected' are no heavier than those of the poorer soils in my immediate neighbourhood! In general terms the corn lands of Great Britain are richer than those on the Continent, and the comparatively low average yield in France, for example, is due to the fact that the thrifty French

peasant grows corn on land that we would not cultivate at all, and so the high yields of the Pas de Calais are pulled down.

Mr. Whetham deals admirably with the law of diminishing returns, and points out that at present prices it would not pay greatly to increase the yield of corn in England, that the extra expenditure on artificials and cultivation would only increase the loss. But it is a very different matter if a considerable increase is secured not only without greater but actually with a decreased expenditure. Lucerne will grow over a wide area of land in England. My own experience is that on poor arable land sown with lucerne which is allowed to stand for six years and then ploughed up, the increase in soil fertility is sufficient to secure for five to nine years subsequent corn crops that will average up to double the corn crop normal to that land; and this with a great reduction to the manure bill. This indicates one direction in which costs of production can be reduced, and I am convinced that still more can be done to reduce costs by the high organisation of the farm as a unit than is generally realised.

As regards the reverse of the medal—prices—I agree with Mr. Whetham that they are a governing factor, but if the prices are low, it is even more important that the farmer should get the potential maximum, that the spread between producer and consumer be reduced by organised marketing. A highly organised industry can always withstand depression better than one that is not organised.

Finally, while I quite agree that England is much more naturally (and economically) a grass country than the Continent, there is no getting away from the facts that much land is under grass which is not suited for grass, that the area of first-class grass land is limited, and that we have millions of acres of poorly handled grass which it would be economic to improve. I do not make these criticisms in any carping spirit, but because I believe it is of supreme importance that agriculturists in Great Britain should realise that the Government is not going to assist them to any material extent, and that it rests with the members of the industry to explore for themselves every avenue that will lead to an improved position. I am convinced that Mr. Whetham's book will prove of utmost value in this direction. It will stimulate thought, and, above all, every one who reads it will have not only a comprehensive but also a balanced view of the agricultural situation in Great Britain as it is to-day.

CHRISTOPHER TURNOR.

Time and Perception.

An Experiment with Time. By J. W. Dunne.
Pp. iv + 208. (London: A. and C. Black, Ltd.,
1927.) 8s. 6d. net.

"'Tis the sunset of life gives me mystical lore,
And coming events cast their shadows before."

(CAMPBELL.)

THROUGHOUT the ages philosophers have amused themselves with time, with little to go on but their own uncertain introspections. More recently the scientific worker has found himself compelled to examine this concept critically and has exposed its interlocking characteristics with space. From the theorist to the experimentalist is a short step in science, but here a difficulty arises from the intangible nature of the material to be handled. There is no doubt that the man-in-the-street, the apparent ultimate arbiter of common sense, does not accord to time the same kind of reality as he accords to other objects in his universe. He has an uneasy feeling that it really is something purely psychological which dies with him, although he uses the same kind of terminology about it as he does about material objects. He talks of 'intervals of time,' of 'time flowing,' and so on; but if pressed he would probably agree with Bergson that only the present exists; past events have existed but do not now, although mental pictures or memories of them exist now; future events do not exist, no memories of them exist now, but pictures of them may be imagined now. The man-in-the-street may, however, be wrong. He has always been wrong, for has he not been rescued from the ignorance of the past? Relativity gave him a shock, but while relativists may contend that A's present may be B's future, so that in a sense A may remember B's future, it is not contemplated that A may remember his own future. If Mr. Dunne is correct, on waking from a dream we may, like the lady in the limerick, "return on the previous night."

There are two distinct portions to this book which ought to be dealt with separately, and the author practically does so. In the first part the startling experimental facts are described which serve as the end to which to direct an equally startling theory. The theory must wait, for it is so strange and unconvincing that the only justification for propounding and examining it would be found if the experimental facts turned out to be unimpeachable. Broadly, the theory assumes that our field of perception of events *moves* through time, and therefore its time-speed must be measured

with reference to another and quite differently dimensioned 'time'; that this 'time' must likewise involve the existence of a third 'time,' and so on, giving what the author calls 'serialism' in time. Similarly our conscious perception of events, perceiving ourselves perceiving, involves the existence of a sequence of observers (ourselves) with the conscious observer at the head of the sequence, another form of serialism. On this as a basis, but apparently by an appeal to geometrical intuitions, the author seeks to show that every time-travelling field of presentation is contained within a field one dimension larger, travelling in another dimension of time, the larger field covering events which are past and future as well as present to the smaller field, and that all these are observable to the serial observer and therefore to the conscious observer at the head of the series. All that remains after that is for the author to show that the 'future' will be best observed when the mind is freed from the normal waking images, and this is what he attempts to do experimentally.

We may safely ignore the theory until the shock of the facts, if so they be, has spent itself. Whatever preconceived prejudices we may possess against what Mr. Dunne proposes to establish—and the present writer has them strongly—it must be at once admitted that the author appears to be a careful, sane experimenter quite alive to the dangers and pitfalls that may beset an observer in a strange field; and if only for the honest and straightforward manner in which he seeks traps and the precautions he takes to eliminate them, his work must be given due consideration.

For years Mr. Dunne has kept a systematic record of his dreams recorded immediately on waking, since dreams fade away so rapidly. He piles up case after case of dreams that have been followed a few days later by their counterparts in actual occurrences. Mere coincidence in one or two details he rules out. For example, to dream of a pile of coins toppling over, and to see such a catastrophe next day, would not suffice. Any bank clerk might experience that without significance, but to dream of a pile of *sixpences* toppling off a *red book* and to experience the event shortly afterwards would require examination. To take an actual illustration at random: while staying at the Hotel Scholastika in Aachensee in 1904 he dreamed he was walking along a path between two fields separated by high railings, when suddenly a horse in a field on his left appeared to go mad, tearing about, kicking and plunging in frenzied fashion. Having glanced at the railings to see that he was safe, he was continuing

on his way, when suddenly the horse, which had somehow entered the path, came after him. It was a full-fledged nightmare. Like a hare he sped towards a flight of stairs at the end of the path, the horse in close chase, when he awoke. Next day, while fishing with his brother, he witnessed a drama which tallied in most of its particulars with the dream. It was his brother who directed his attention to the plunging horse. Looking up, he saw the fields—smaller than in his dream—the path, the railings (also smaller), and the flight of stairs leading to a bridge over the river. In a moment the horse had jumped the railings and was tearing down the path towards them as if demented. It swerved, avoided the stairs and plunged into the river, swam towards the fishers, clambered out of the river, snorted, and calmly trotted off.

These dreams the author claims were not impressions of distant or future events, but merely the usual commonplace dreams composed of distorted images of waking experiences, strung together in the usual half-senseless fashion peculiar to dreams. If they had happened on the nights *after* the events they would have exhibited nothing in the smallest degree unusual, but they occurred on nights *before* the events. The author claims to have convinced a number of sceptical friends who placed themselves under his guidance that such dreams occur to them also, so much so that one of them endeavoured to use it to spot a Derby winner!

If this work is not a practical joke, and it does not sound like it, and if the author is sane, and there is ample contributory evidence of this, the subject he has opened up ought to be examined so that his contentions are either substantiated or demolished. The ordinary scientific worker will not easily concede that in effect unknown future events can influence the state of the brain in the present, except indirectly in the sense that the present state of the brain and the future events may be affected by a common agency. It is quite possible, on the other hand, that certain of the confirmatory events described that mainly involved action on the part of the author may actually have been suggested by the dreams. The present writer once dreamt that he had invented an incandescent gas mantle which he in his dream called the "Elijah Mantle"! He has often since then thought of following up the suggestion. Although many of the illustrations vouched for in this book would be exceedingly difficult to explain away on these hypotheses, it would appear to be the hypotheses, if not the only ones, on which to proceed once the evidence has been thoroughly verified and sifted.

H. LEVY.

Popular Biology.

Essays in Popular Science. By Prof. Julian Huxley. Pp. xii + 307 + 6 plates. (London: Chatto and Windus, 1926.) 16s. net.

THE task of the populariser is becoming more and more difficult. If he attempts to produce something better than the superficial stuff that is served up by the popular Press, he is met with two difficulties: first, that science itself is over-specialised, and the results achieved in each little compartment of study are of interest only to the very few who can appreciate them; and secondly, that the cultivated public on the whole lack the necessary mental background of scientific knowledge and the understanding of scientific method which would enable them to assimilate results of major or general value. But if his task is more difficult, it is also more important, and in both directions. For not only can he exercise great influence on the general thought of the community by skilful presentation of the matured and general results of scientific research, but he can also do great good to science itself by taking a bird's-eye view of the specialists' domains and extracting from their multifarious details something of general import, some view or theory which may not be altogether accurate, but may act as a stimulus, or even as an irritant, and lead to more adequate synthesis. There is a close connexion in fact between popularising and generalising.

It is too often forgotten that science does not consist in the mere accumulation of knowledge, that facts buried away in papers and text-books do not by themselves constitute science. There is needed in addition the spirit of synthesis and the power to fuse all the facts into a coherent system which in its turn shall link up intelligibly with some general philosophical *Anschauung*. Prof. Huxley expresses this all-important point admirably in the following passage:

"The works of man only live in so far as man vivifies them: and this *corpus* of fact that to some people constitutes the reality of natural science is only a vast stamp-collection, no more than a lumber room, unless each generation in its turn will make it live. It lives most strongly (so is the human mind constructed) by being woven into the general background of some general philosophy of things. The history of science shows us how a body of fact, comparatively inert and lifeless while held in one framework of opinion, may be seized by another more vigorous movement of the mind and used as a living battering-ram to beat open the doors of progress" (p. 164).

Better, on the whole, a wrong or premature synthesis than no synthesis at all. It is a curious fact that some of the most potent theories, theories that have most stimulated thought and research, have been found in the long run, after a period of vogue, to be very largely wrong. One might instance Weismann's brilliant theory of the germ-plasm, which exercised an extraordinarily powerful and lasting influence on biological thought.

The present volume of essays by Prof. Julian Huxley is a more heterogeneous collection than his previous book entitled "Essays of a Biologist," and some of the shorter articles and reviews might well have been omitted. There remain, however, many papers of real value, of interest both to the general public and, particularly in one case, to the professional biologist. Prof. Huxley's gifts as a popular exponent of biological science are undoubted; he is always lucid and interesting, and links up his themes with human life and literature in such a way as to appeal to any cultivated reader.

The first half-dozen articles deal with the problems of heredity and sex in the light of modern genetics. It seems to us that Prof. Huxley states the gene theory in too confident terms. The paper on "Chromosomes, Mendelism and Mutation" is a triumph of lucid exposition, but it will give the ordinary reader the impression that the problems of heredity are all solved. But this is far from being the case. Other articles deal with "The Control of the Life-Cycle," "The Meaning of Death," "Birth Control," "Evolution and Purpose," and there is a sympathetic and penetrating study of the author's grandfather and his attitude towards religion. Apart from a number of re-published reviews, the rest of the volume is taken up by two papers, hitherto unpublished, on "The Frog and Biology" and "The Tadpole: a Study in Developmental Physiology," the latter based upon an address delivered at the British Association meeting in Liverpool. The paper on the frog gives an interesting and well-illustrated account of the action of internal secretions upon metamorphosis and colour-change; the other, some 85 pages in length, is a very valuable sketch and well merits attention from the professional biologist—it is rather too 'strong meat' for the ordinary reader. We have here a good summary and a thoughtful discussion of the modern work by Spemann, Harrison, and others, on this classical object. One is interested to see that the quite fundamental ideas of Wilhelm Roux on the importance of function are at last being given the attention they deserve.

E. S. R.

Our Bookshelf.

- (1) *A View of Sierra Leone*. By F. W. H. Migeod. Pp. xii + 351 + 8 plates. (London: Kegan Paul and Co., Ltd., 1926.) 31s. 6d. net.
- (2) *Sierra Leone: its History and Tradition*. By Capt. F. W. Butt-Thompson. Pp. 275 + 11 plates. (London: H. F. and G. Witherby, 1926.) 15s. net.

(1) MR. MIGEOD has given us the results of a visit to Sierra Leone of six months' duration in 1925. His book falls into two parts: the first, a descriptive narrative dealing with the colony, its people, and something of their history; the second, an analytical account of the Mende, their physical anthropology, social organisation, secret societies, religious beliefs, games, songs, and folklore. Their language is dealt with in an appendix. Sierra Leone, being one of those parts of Africa outside the northern radius which has been longest in contact with European civilisation, presents many difficulties to the student of culture, which are by no means mitigated by the presence of the Creole and Mohammedan elements. Mr. Migeod, an anthropologist with a conscience which sets a high standard, is keenly conscious of these difficulties, and they must be held responsible for much in the first part of the book which the reader may regard as scrappy and incomplete.

(2) Mr. Migeod devotes his opening chapters to the identification of places mentioned by early geographers which, there is reasonable probability to conclude, were situated in this part of Africa. Capt. Butt-Thompson writes of an area much more restricted than that covered by Mr. Migeod. Instead of the Sierra Leone of to-day with its three 'Provinces' and thirteen 'Districts,' he deals only with the history of the colony comprised in the peninsula on which Freetown stands. Nor is he concerned with the chronicles of the earliest voyagers. His history begins in the sixteenth century with the movements of peoples down to the river and the conquests of the Temne kings, which are recorded in or may be deduced from the reports of Ogilby, Fletcher, and others.

Capt. Butt-Thompson writes with a wealth of detail, and much of his material, gathered by members of his own family, has not previously been published. Much is derived from oral tradition. Travellers, colonists, missionaries, and administrators are all passed under review, and their achievements, both good and bad, recorded with commendable impartiality. Capt. Butt-Thompson's book will serve as a valuable guide to those who wish to understand the conditions out of which have grown the many and serious problems with which the administration is confronted to-day.

The Analysis of Pigments, Paints, and Varnishes. (Oil and Colour Chemistry Monographs.) By Dr. J. J. Fox and T. H. Bowles. Pp. 179. (London: Ernest Benn, Ltd., 1927.) 16s. net.

THIS is a book which can be heartily recommended to all who are concerned with the chemical examination of the materials in question. It is, in

fact, in many respects the best of all those dealing with the subject. The first 124 pages deal with the analysis of pigments, white, red, blue, yellow and brown, green and black; then follow two chapters dealing respectively with the analysis of mixed paints and with the examination of varnishes. Three appendices dealing with (a) specimen analyses, (b) a method for the determination of tung oil in paints and varnishes, and (c) distempers, together with index of subjects and index of names, complete the work.

Each subject is treated in a comprehensive manner and the methods given or recommended are those which the authors, in the course of their large and varied experience, have found to be trustworthy. They are especially useful in the case of some of the rarer pigments, which are so frequently in analytical works either ignored or dismissed by a reference to "the usual methods of analysis" that, when applied, are so often found to fail. Full analytical details are always given, a course which should always be followed in analytical methods of this description. A large number of references appear at the end of each chapter, enabling any analyst who wishes to do so to consult the original papers. It is gratifying to note that the authors have made use of the specifications of the British Engineering Standards Association, to the committees of which they have given so much valuable advice. In view of the tendency to give viscosities in C.G.S. units, the authors have rightly included instructions as to how this can be done (pp. 144-150), and it is to be hoped that with this lucid description now available, those concerned with the examination of varnishes will record the viscosities of the varnishes in C.G.S. units and not, as has been so frequently the case in the past, in arbitrary units which mean little or nothing to any one other than the observer. The only small criticism we have to offer is that the symbol pH might have been briefly explained (p. 163), as we know from experience that there are still a number of paint and varnish 'chemists' who are not conversant with its real meaning.

In conclusion, we have no hesitation in saying that this book should be in the possession of every pigment, paint, or varnish works' laboratory.

G. R.

Constitution et évolution de l'univers. Par A. Verronet. (Encyclopédie scientifique: Bibliothèque d'astronomie et de physique céleste.) Pp. 475. (Paris: Gaston Doin et Cie, 1927.) 28 francs.

In the larger problems of astronomy it is not to be expected, or indeed to be desired, that there should be universal agreement. The subject of this book, as indicated by the title, is the ultimate problem of all astronomical and physical research, and a final pronouncement at the present time is obviously out of the question. Cosmogony, in fact, has only just emerged from the field of unalloyed speculation, and the tentative hypotheses which can now be put forward are more of the nature of convenient summaries of known facts and indica-

tions of new directions of observation than aspirants to the dignity of absolute truth. In the volume before us, M. Verronet, following lines of thought previously laid out by Henri Poincaré, considers the problem of the past, present, and future constitution of the individual bodies in the universe and of the universe as a whole. He reaches some very definite conclusions, which differ considerably from the more familiar views which we associate chiefly with the names of Eddington, Jeans, and Russell. For example, he maintains that the interior of a star is homogeneous, and has a sensibly uniform temperature about double or triple the surface temperature. Needless to say, he rejects Eddington's theory of radiative equilibrium, which he regards as being mathematically impossible. The age of the sun is placed at a few million years, and the past history of the universe is held to be almost negligible in duration compared with the future. These views are sufficiently unfamiliar to attract attention, and since M. Verronet gives reasons for the conclusions at which he has arrived, his work demands respectful consideration. It will doubtless not meet with general acceptance, but may nevertheless have some part to play in the advancement of knowledge.

Cours de physique à l'usage des élèves de l'enseignement supérieur et des ingénieurs. Par Prof. Jean Becquerel. Tome 2: *Elasticité. Acoustique.* Pp. ii+427. (Paris: J. Hermann, 1926.) 6s.

THE second volume of Prof. Becquerel's treatise on physics contains sections on elasticity and sound, the former subject occupying about one-quarter of the available space. The first chapter deals with the physical study of elasticity and the determination of the elastic constants; the second treats of the mathematical theory of elasticity. On the experimental side particular attention is given to the researches of Wertheim and of Amagat; on the theoretical side the aim has been to emphasise only essential questions and to derive the formulæ necessary for the propagation of waves in a homogeneous, isotropic medium. This discussion paves the way for the treatment of wave propagation in the next chapter, which deserves special mention for lucidity of treatment. In fact, throughout the volume the author gives an exceptionally clear exposition of what may be termed the classical theory of acoustics. Stress is laid for the most part on the mathematical rather than on the experimental aspects of the subject, but there is a valuable chapter dealing with the applications of acoustics in music which is unusually complete for a book of this character.

On account of the greater novelty of the subject matter and of the methods employed, the last three chapters in the book are, perhaps, the most interesting. The first of these deals with noises heard in the air, underground, and under water; instruments are described, many of them devised for use by the French army during the War, for determining the direction of the source of sound, and the subject of range-finding is given a chapter

to itself. Finally, we have a short but suggestive chapter on the acoustics of halls, containing an account of the experiments of Sabine and of Marage.

The Preparation and Analysis of Organic Compounds. By J. Bernard Coleman and Dr. Francis Arnall. Pp. xvi+352. (London: J. and A. Churchill, 1926.) 15s. net.

THE task of an author in compiling a text-book of practical organic chemistry is by no means an easy one, on account of the difficulty in framing a systematic scheme of qualitative organic analysis. The present authors, however, have made a very successful attempt to give a rational scheme of analysis of unknown organic substances and mixtures.

About a third of the book is devoted to a systematic description of the methods of synthesising the important members of the main groups of organic substances, the reactions, preparation, and properties of which are described, together with notes on precautions necessary to be observed. This forms a striking feature of the book, as the complete experimental detail for the preparation of eighty-nine representative bodies is associated with an explanation of the theoretical processes involved.

The next portion deals with the qualitative analysis and identification of organic compounds, and this, equally with the preceding section, has been carefully devised and should prove of great value to students. The systematic manner in which the properties of different types of organic substances are displayed appears to the reviewer to be specially valuable, although from his personal experience a few of the physiological tests, such as those depending upon smell, are not in accordance with his own observation.

Finally, there is an excellent portion dealing with methods of ultimate analysis and estimation of typical groups.

This book can be confidently recommended to students of organic chemistry. L. C. N.

The Amarna Age: a Study of the Crisis of the Ancient World. By the Rev. James Baikie. Pp. xix+465+32 plates. (London: A. and C. Black, Ltd., 1926.) 12s. 6d. net.

WHEN the discovery of the tomb of Tutankhamen was made the occasion of a newspaper 'stunt,' some misgiving was felt whether such wide publicity was likely to be a real benefit to archæology in the long run. In that particular instance it probably was not; but it had the advantage that it made the general public to a certain extent familiar with a very important period in Egyptian history. Indeed, as Mr. Stanley Cook says in his preface to Mr. Baikie's excellent account of the Amarna age, it was one of the great crises in the ancient world. Mr. Baikie's book has been written for those whose interest in this period has been aroused by the discovery of the tomb, and it is for such that he has been anxious, incidentally, to fit that discovery into its true perspective by placing it side by side with the less sensational but far more important

discovery of the Tel-el-Amarna tablets to which we owe our detailed knowledge of the history of this period and from which he quotes freely.

The greater part of Mr. Baikie's book is concerned with the political, military, and diplomatic history of the expansion and decline of the Egyptian empire, but naturally the character and religious reform of Akhenaten occupy a prominent position. Mr. Baikie discusses the origin of the Aton worship, but, while he acknowledges the existence of a strong Mitanni element in Egypt, he is not inclined to admit Asiatic influence in either its universality or its monotheistic tendency.

A Guide to the Orchids of Sikkim: being a Guide to the Identification of those Species of Orchids found between the Terai and the Northern Frontier of Independent Sikkim, including the Chumbi Valley and British Bhutan. By Prof. Paul Brühl. Pp. xvi+208. (Calcutta and Simla: Thacker, Spink and Co., 1926.) 5 rupees.

THIS little book will be warmly welcomed by lovers of the flora of the Darjeeling district. The text takes the form of a key, first to the genera and then to the species, the alternatives on the whole being well chosen and distinctly expressed. Unfortunately the technical finish of the book is not so satisfactory, there being a number of misspellings of generic names, while the taxonomy is not always in line with present-day conceptions; for example, *Tainia hookeriana* has been referred to *Ascotainia* for about twenty years, while *Cypripedium venustum* has not been included by botanists in that genus since 1898. At the same time a book of this nature seems scarcely the most suitable place for the publication of a new genus (*Cleisocentron*). Nevertheless, Prof. Brühl may be congratulated on having produced a useful guide to Sikkim orchids. V. S. S.

Lehrbuch der Elektrodynamik. Von Prof. Dr. J. Frenkel. Erster Band: *Allgemeine Mechanik der Elektrizität.* Pp. x+365. (Berlin: Julius Springer, 1926.) 28.50 gold marks.

As the title implies, this is an attempt to treat electromagnetic theory as a branch of general mechanics. The fundamental unit is not the charged particle, the existence of which depends upon the existence of the corresponding opposite charge, but the electric doublet or dipole, the moment of which vanishes in a neutral particle. This makes it possible to deal with vector quantities, instead of the scalar quantities represented by 'charges.' Vector algebra is therefore liberally employed, and the author devotes 36 pages to a consideration of its principal operations. It becomes necessary to regard electrons as geometrical points, or rather as point singularities in the space-time continuum. The author, as is natural in the atmosphere of Leningrad, seeks to break with the historical development of electricity, and as a first step discards the conception of the ether, which he regards as obsolete. It is an interesting attempt, but whether it will be fruitful is another matter. E. E. F. D'A.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Pinholes in Photographic Negatives.

PINHOLES are a serious problem in the case of some photographs. For example, a number of pinholes in a delicate cloud photograph will quite spoil the effect, unless they are carefully spotted out. Spotting out may be easy for a professional, but the ordinary amateur finds a considerable difficulty in doing it properly, and if lantern slides are to be made the technique is still more difficult.

The common cause of pinholes is that small particles get on the face of the plate and during exposure they cause shadows, which on the resulting negative appear as clear patches. Particles may get on to the plate at various stages of its history, but the plate makers never, or scarcely ever, admit that any particles can be on the plates before they are taken out of their wrappings. My own experience, however, is against this supposition. My procedure, up to quite recently, has always been the same; I have dusted out the dark slides, opened the packets of plates very carefully, and very carefully put the plates into the dark slides; but pinholes sometimes occur and sometimes do not, and the occurrence or non-occurrence of pinholes coincides with the use of a new box of plates. With all the plates from one box I may get many pinholes, with all the plates from another I get very few; the inference is that the particles that cause them are on the plates as they come from the makers. Moreover, I have opened plates in the light and have found minute particles on their faces. Quite recently I have heard indirectly from a leading firm of plate makers that it is almost impossible to prevent small fragments of glass from the cut edges of the plates from getting on to the sensitised surface; this agrees with my experience that the pinholes are worse round the edges of a plate than near the centre. The above observations were made on plates that had not been carried about in a dark slide. Of course, if this is done, pinholes must be expected even on plates which were the most immaculate when they left the maker.

Since apparently plates can, and do, leave the makers with foreign particles on their faces, it would appear to be necessary to remove the particles before the plate is put into the dark slide. Thirty years ago or so the amateur used to be told to dust his plates; more recently, however, he has been told on no account to do this; it has also been stated, and often repeated, that dusting plates electrifies them and causes small particles to be attracted. No one who has so written can have tried the experiment; at ordinary room temperature and humidity I find that it is not possible to electrify a plate even by a very vigorous rubbing of the coated side. When, however, the plates are made very hot, and therefore dry, they can be electrified by fairly moderate rubbing; if, however, they are left for half an hour or so, they are found to have returned to their original condition. Backed plates are still more difficult to electrify by rubbing, though different makes differ in this respect; some backed Ilford Special Rapid Panchromatic and Wellington Spectrum plates showed no electrification when rubbed vigorously, even when heated to such a temperature that they could scarcely be touched by the hand; some backed Imperial Panchromatic plates, however, were easily electrified by

rubbing, when made very hot. The Ilford and Wellington plates could be electrified by rubbing if the backing was removed and if they were heated. Thus in the ordinary way, at room temperatures, there is no danger of electrification even if the plates are rubbed quite vigorously. I now wipe the sensitised surface of the plate with a pad of velvet, and have found a very considerable diminution of pinholes as a consequence; a single sweep of the velvet across the plate is sufficient.

Probably a professional finds little difficulty in spotting out pinholes, but, as I have said, the amateur finds a good deal of difficulty. When using water-colour, for example, if there is too much colour on the brush, or if it is too watery, the colour leaves the pinhole and collects in a circle round it, thereby aggravating the evil; if one uses the brush very nearly dry it entails taking fresh colour for nearly every pinhole, and the process becomes very laborious. I have lately, however, taken to using ink supplied by the Cambridge Instrument Co. for their recording apparatus; this ink consists of colouring matter dissolved in nearly equal proportions of glycerine and water with a small admixture of gum arabic. This used with a fine brush makes the best medium I know of for spotting out pinholes; it takes longer to dry than, say, water-colour, but this disadvantage is far outweighed by its ease of application.

C. J. P. CAVE.

Stoner Hill,
Petersfield, Hants, May 25.

The Polymorphism of Higher Fatty Acids.

IN continuation of former work, I have extended the study of the polymorphism of such substances (Piper, Malkin, and Austin, *Jour. Chem. Soc.*, 1926, 2310; J. Thibaud, *Comptes-rendus*, 184, 24 and 96, 1927; de Boer, *NATURE*, Jan. 8, 1927) to the even and odd series of saturated acids of higher molecular weight. Thin films are prepared on a glass slip either by melting or by evaporating from a solution in ether, or better in carbon disulphide, and examined with respect to the $K\alpha$ rays of copper by the turning crystal method. The result is as follows: the long spacing measured for an evaporated film differs from that obtained from a melted acid, the latter being smaller than the former. This property is quite general: for every acid which contains more than 16 carbon atoms in the molecule, the magnitude of the long spacing depends on its manner of preparation and the two kinds thus possible both seem very durable. For stearic acid I have been able to obtain upon one and the same evaporated film, two coexistent crystalline modifications.

The following table summarises the data obtained with the even and odd series of saturated acids:

Acid.		Spacing (Å.U.) of the Modification.	
		Evaporated	Melted.
Myristic	$C_{14}H_{28}O_2$	31.2	31.2
Palmitic	$C_{16}H_{32}O_2$	38.8	35.4
Daturic	$C_{17}H_{34}O_2$	43.2	41.4
Stearic	$C_{18}H_{36}O_2$	43.95	39.9
Arachidic	$C_{21}H_{42}O_2$?	59.0	53.4
Cerotic	$C_{27}H_{54}O_2$	69.0	64.2
Melissic	$C_{31}H_{62}O_2$	80.4	73.5
Lacceroic	$C_{32}H_{64}O_2$	82.0	73
Sebacic	$C_{10}H_{18}O_4$	11.4	11.4

In the accompanying diagram (Fig. 1) the observed spacings are plotted against the number of carbon atoms of the corresponding acid. Piper's values and my data are complementary. The diagram shows that, for every modification, the spacings lie upon nearly straight lines (even acids show a small increase in their lines with increasing molecular weight) and it is necessary to consider a bundle of straight lines for the even acids and another for the odd ones. The lines of the "evaporated" B-modification lie above those of the "melted" C-modification. The increase of the chain's length per C-atom is respectively 1.327 and 1.146 Å.U. for the B- and C-kinds of odd acids, and 1.21 and 1.10 Å.U. for the B- and C-kinds of even acids.

It is to be noted that arachidic acid, which was examined in several samples, exhibits for these two B- and C-modifications, numbers well placed upon the even-acid diagram for 24 C-atoms, in good agreement with Piper's data for lignoceric acid. Therefore I ascribe 24 atoms to arachidic acid.

By comparison an attempt to show the polymorphic properties of a dicarboxylic acid ($C_{10}H_{18}O_4$) was unsuccessful. Afterwards, having a crystal of stearic acid, which was comparatively large and showed the long spacing (44 Å.U.) of a B-modification, I investigated the distribution of the scattering matter in this

stearic film (C-modification) a maximum occurs at the 18th-20th order. Then the distribution of matter in a chain of a B-modification is similar to that of a C-modification, but it shows a small discrepancy in the situation of the terminal CO_2H groups.

In addition to the long spacings there is a number of small ones which afford information concerning

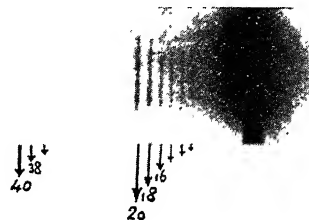


FIG. 2.—Stearic acid ($Mo\ K\alpha$).

the structure of the CH_2 -chain. For all acids mentioned in the preceding table and for micro-crystalline films showing the B- as well as the C-modification, I have registered the rays from these small spacings by means of the turning crystal or by Debye and Scherrer's ring method. The small spacings appear unchanged in magnitude as well as in relative intensities whatever may be the purity or crystalline variety of the acid investigated. It follows that for every saturated acid the arrangement of the C-atoms in the chain is precisely the same and is in agreement with data of a beautiful work of Müller (*Proc. Roy. Soc.*, April 1927, p. 542) upon stearic acid.

I have to thank Mr. de Broglie for advice during this work.

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Quantum Theory and Gravitational Relativity.

WE wish to announce a result which indicates an inner unity between the quantum theory and gravitational relativity. The connecting link is the wave theory of Schrödinger.

Einstein's gravitational relativity is an invariantive treatment of particle dynamics, with respect to transformations of co-ordinates. Hence the notions of clocks, yardsticks, moving observers, etc., which he introduces to make his theory plausible, belong primarily to the classical kinematics of particles. On the other hand, Schrödinger makes his fundamental physical phenomenon a wave phenomenon: that is, a phenomenon expressed by a linear hyperbolic differential equation of the second order in four variables. It is thus not unnatural to seek for the real meaning of the Schrödinger theory in an invariantive investigation, not of a quadratic form, as in Einstein's theory, but of a differential equation:

$$\sum_{\lambda, \mu}^{1, \dots, 4} g^{\lambda\mu} \frac{\partial^2 \psi}{\partial x^\lambda \partial x^\mu} + \sum_{\lambda}^{1, \dots, 4} \gamma^\lambda \frac{\partial \psi}{\partial x^\lambda} + g_0 \psi = 0, \quad g^{-1} = \text{Det}[g^{\lambda\mu}] \neq 0.$$

Cotton (*Annales scient. de l'école normale supérieure*, 3^e sér. 17, 211-244; 1900; comp. also T. Levi-Civita, *Atti R. Istituto Veneto*, 8^a ser. 15, parte 2, 1331-1357; 1913) has shown that this equation can be written in the form

$$\square \psi - 2 \sum_{\lambda}^{1, \dots, 4} p^\lambda \frac{\partial \psi}{\partial x^\lambda} + (-D + F - H(x^1, x^2, x^3, x^4)) \psi = 0,$$

where $g^{\lambda\mu}$ is a contravariant tensor, p^ν a contravariant vector, and

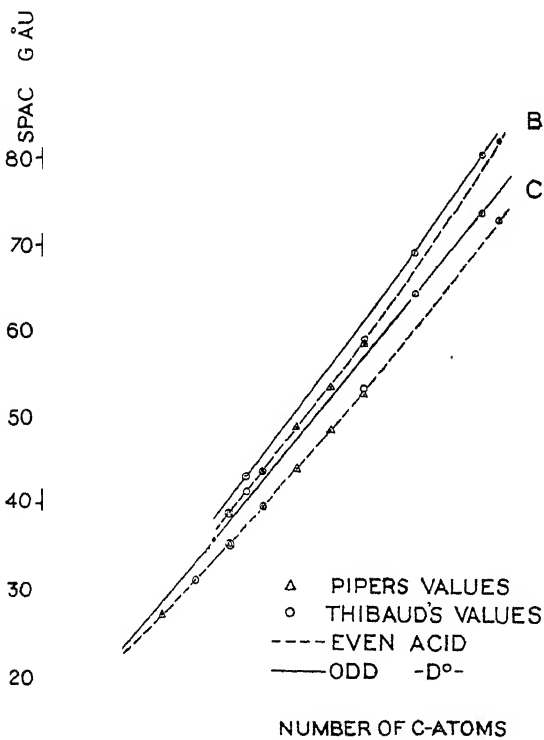


FIG. 1.

chain from a study of the higher orders of reflection (Muller and Shearer, Prins and Coster) from the long spacing, by means of the $K\alpha$ copper and molybdenum rays. The spectrum (Fig. 2) shows first, that the odd orders are much stronger than the even; then, from the 10th order onwards the even orders are the stronger, their intensities increasing regularly to a maximum at the 20th order, afterwards decreasing abruptly. Later maxima occur at the 38th and more strongly at the 40th order. With a melted

$$\square\psi = \frac{1}{\sqrt{g}} \sum_{\alpha, \beta}^{1, \dots, 4} \frac{\partial}{\partial x^\alpha} \sqrt{g} g^{\alpha\beta} \frac{\partial \psi}{\partial x^\beta}, \quad D = \frac{1}{\sqrt{g}} \sum_{\alpha}^{1, \dots, 4} \frac{\partial}{\partial x^\alpha} \sqrt{g} p^\alpha,$$

$$F = \sum_{\alpha, \beta}^{1, \dots, 4} g_{\alpha\beta} p^\alpha p^\beta, \quad H = D - F + g_0.$$

As Cotton points out, if we suppose that

$$K - 6H = \text{Constant} = 6C,$$

K being the curvature scalar of the $g_{\lambda\mu}$, the $g_{\lambda\mu}$'s and the p^α 's are in general determined in one and only one way. If we identify the $g_{\lambda\mu}$'s with those of Einstein, and assume his equations

$$K_{\lambda\mu} = 0,$$

where $K_{\lambda\mu}$ is the contracted curvature tensor, it follows that $K = 0$, and $H = -C$. If we take for our constant of normalisation :

$$C = \frac{4\pi^2 m^2 c^2}{\hbar^2},$$

where m is the rest mass of the electron, c the velocity of light, and \hbar the Planck constant, our wave equation assumes the form of the relativistic Schrödinger equation as given by De Donder in *Bull. Classe des Sciences, Acad. Royale de Belgique*, séances du 5 février et du 5 mars, 1927. Thus the quantisation of the Schrödinger equation is determined by the Einstein equations.

The vector p_α , apart from a constant factor, determines the electromagnetic vector potential. The Maxwell auxiliary equation, as De Donder points out, is $D = 0$. This can be satisfied without affecting our previous considerations if we change our dependent variable ψ by multiplying it by an appropriate factor of calibration.

To sum up, if we define our gravitational field in the proper invariantive manner in terms of a wave equation, the quantisation of this equation follows from the gravitational field equations. The equation also defines an electromagnetic potential, to which most of Weyl's considerations apply.

A detailed discussion of the present theory will appear in a near number of the *Journal of Mathematics and Physics of the Massachusetts Institute of Technology*.

NORBERT WIENER.

D. J. STRUIK.

Department of Mathematics,
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Cambridge, Mass., U.S.A.,
April 2.

We can make our fundamental equation homogeneous in order by the substitution $u = \psi e^{i\alpha}$. We then obtain a treatment of our theory analogous to that of O. Klein, *Zeitschr. f. Physik*, **37**, 895-906; 1926. The fifth dimension turns out to be a mere mathematical convention that can be compared to the introduction of homogeneous co-ordinates in other parts of mathematics.

May 10.

Structure of Pearls.

IN a recent paper by Dr. Orton and myself (*Jour. Marine Biol. Assoc.*, vol. 14, No. 4, in the press) it has been pointed out that a thin, brown horny layer occurs in the form of a skin on the inner surface of the shell of oysters (*Ostrea edulis*), and is especially well developed in those from the Fal Estuary beds, in addition to the four normal strata found in the shells of lamellibranchs. This layer was found to peel off in specimens collected in the autumn of 1926, thus indicating that it was secreted at the end of the

autumn period of growth. Layers of similar material have been found by us in sections of oyster shells (*O. edulis*) and by Römer in the shell of *Margaritana* (*Zeitschrift für wissenschaft. Zoologie*, 1903, 437, Taf. XXXI., Fig. 14), alternating with layers of nacreous material. It is well known from the work of Herdman and Jameson that the structure of pearls from *Margaritifera vulgaris* is intimately related to the structure of the shell, and that new shell growth and pearl growth are probably comparable phenomena. It is also known that layers of brown material similar to that found in shells are also found in some pearls. The occurrence of a layer of brown horny material on or in the shells of *O. edulis* indicated, therefore, that similar layers might be found in the pearls taken from *O. edulis*.

In order to determine the structure of pearls from *O. edulis*, ten dry specimens were decalcified in about 20 per cent. hydrochloric acid. Some time after the pearls were immersed in the decalcifying fluid, it was noticed that two still remained at the bottom of the fluid, whereas the remaining eight were floating, due to bubbles of carbon dioxide becoming entangled in the meshwork of the organic matter left after the calcium carbonate had been dissolved from the calcareous layers. The two specimens that did not float were the only ones that were brown in colour, while the remainder were of nacreous lustre. All the specimens were dehydrated, cleared, and sectioned by the usual method. The eight 'white' pearls showed rings of organic matrix (conchyolin) with discontinuous layers of brown horny material, and with an inorganic nucleus. The two 'brown' pearls could not be sectioned completely, but a few sections (8 μ thick) of the outer horny layer were obtained. On microscopic examination these sections showed a brown matrix in which rhombic crystals were embedded, and could not be stained with water-blue. In properties and structure, the outer layer of the above-mentioned 'brown' pearls resembles the brown horny layer found on the inner surface of the shell of *O. edulis*.

Three other pearls from *O. edulis*, which had normal lustre, obtained in October 1926 from Yealm oysters, were mounted dry; after a few days, the outer coating of one broke off, exposing a brown horny layer similar to the one described above. It would appear that this brown horny layer is more related to periostracum on account of its horny nature and unstainable properties than to the organic matrix of the prismatic or nacreous layers. It is also probable that this brown layer is homologous to the 'conchyolin' layer found in the shell of *Margaritana* by Römer (*loc. cit.*) and to the 'amorphous substance' found in pearls from *Margaritifera vulgaris* by Jameson (*Proc. Zoo. Soc.*, 1912, Pl. XLII., Fig. 41).

Herdman (Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Mannar, Parts I.-V., 1903-6) classifies true pearls into (a) cyst pearls and (b) muscle pearls. When pearls are found in the edge of the mantle they are brown, because they are composed of periostracum, which is the normal secretion of the edge of the mantle. When pearls occur in the region of the muscle attachment they possess a lustre due to their hypostracal composition, which is the normal product of that region. When pearls are formed in the mantle or in the epithelium of the visceral mass, they possess a lustre due to the nacreous secretion, which is the normal product of those regions. From the above statements it is clear that brown pearls would appear in the region of the visceral mass, or of the mantle, only when the normal rhythmic secretion is disturbed.

Jameson (*loc. cit.*) states that "it would appear that the lime salts and the albuminous fluid which

hardens to form the conchyolin are independent of each other and may be secreted in varying proportions." Under favourable conditions the secretions of the shell-secreting epidermis are so regulated that nacreous layers are formed. It is possible that under unfavourable conditions, such as a fall in temperature or the want of lime in the food of the animal, only the horny layer is secreted. It is therefore suggested that the brown horny layers found in the pearls of *O. edulis* and on the inner surface of the shell of *O. edulis* are identical.

The occurrence of concentric layers of horny periostracum-like substance in pearls generally and in the shells of oysters and other molluscs may therefore be due to a disturbance in the rhythmic action of the secreting epithelia whereby only the first part of a phase of shell-formation is completed with the oncoming of winter or at the end of a shell-growing period.

C. AMIRTHALINGAM.

Marine Biological Laboratory,
Plymouth, May 14.

The Absence of a Cellulase in *Limnoria*.

OWING to the almost invariable presence of fragments of wood in the stomach and gut of the wood-boring isopod, *Limnoria lignorum*, it has been assumed that this animal is capable of digesting cellulose. Thus Calman (Brit. Mus. (N.H.) Economic Series No. 10) states: "*Limnoria* certainly swallows, and probably digests, the wood which it gnaws away to form its burrow, but it is not known whether it has any other source of nourishment." In a report on the Marine Piling Investigation, published in the Bulletin of the American Railway Engineering Association (vol. 28, No. 290, Oct. 1926), the definite statement is made that "the main food of the *limnoria* is the wood into which it bores." No experiments on the digestive powers of *Limnoria* appear to have been made, and it is never advisable to draw definite conclusions as to the food of any animal from the contents of its stomach, for a great deal of material may be passed through the gut which cannot be acted upon by the digestive enzymes. Though it is known that wood is ingested intracellularly by *Teredo* which, as shown by Harington (*Biochem. Jour.*, vol. 15, p. 736) and Dore and Miller (*Univ. Calif. Publ. Zool.*, vol. 22, p. 383), possesses a cellulase, it by no means follows that a similar enzyme is present in the crustacean, *Limnoria*, in which both the alimentary system and mode of digestion are totally different.

In the hope of discovering whether wood can be digested by *Limnoria*, I carried out a series of experiments during a period of work on behalf of the Sea Action Committee of the Institution of Civil Engineers. Great numbers of *Limnoria* were collected by placing infected wood in sea water containing 20 per cent. of alcohol, as a result of which the animals came out of their burrows in great numbers and were collected from the bottom of the vessel. They were carefully isolated from other organisms, dried on filter papers and weighed. In the first experiment 2.6 grams of *Limnoria* (i.e. very many hundreds) were collected, and in the second 0.63 grams. They were then ground up with sand and an extract made in toluol water. The action of this extract was tested on sawdust, the digests being incubated at 32° C. for two weeks in the first experiment and for four weeks in the second. Control experiments were carried out with the boiled extract, while in the first experiment the action on starch was also tested. No indication of any digestion of the cellulose in wood was found in either experiment, although the starch was quickly digested, the presence of glucose being indicated by means of Benedict's solution.

It appears, therefore, that *Limnoria* does not possess an enzyme capable of attacking cellulose. Such enzymes are rare in the animal kingdom, as I have pointed out elsewhere (*Science Progress*, vol. 20, p. 242) in a résumé of the literature on the subject. There is, moreover, no evidence of the presence of protozoan symbionts in the stomach of *Limnoria*, such as are invariably present in the gut of the wood-boring Termites, which enable these insects to extract nourishment from the wood (Cleveland, *Biol. Bull.*, vol. 46, p. 177, and subsequent papers). There remains the possibility of bacterial digestion, but, owing to the difficulty of obtaining sufficient material from the minute stomachs, no experiments were carried out.

Examinations of the stomach contents revealed the presence of a certain quantity of microscopic plants and animals such as diatoms, peridinians, etc., and no doubt more would have been identified but for the trituration of the gastric mill and the action of digestive enzymes in the stomach. There is a large micro fauna and flora on the wood which may quite easily supply the needs of the animals. It would appear at first sight as though this would not be easily obtained in the burrows, but, as recorded by Calman (*l.c.*), *Limnoria* has been found boring in the insulating covering of a submarine cable in the Mediterranean, so that it obviously can feed in this manner, since it is in the highest degree unlikely that it can digest the substance of the cable! *Teredo* is never found burrowing in anything but wood (though the giant *Teredo* apparently spends at least the latter part of its life encased in its calcareous tube buried in the sand), but *Xylophaga*—an allied genus resembling *Teredo* in its burrowing apparatus but not in the modifications of the gut which enable it to digest wood—has also been found burrowing into the covering of cables.

The amphipod borer, *Chelura terebrans*, resembles *Limnoria* in all respects. Experiments revealed the absence of a cellulase, there are no symbionts, the stomach contents are similar to those of *Limnoria*, and it has been found boring into the covering of cables.

There appears, therefore, to be every indication that *Limnoria* and *Chelura* bore into wood solely for protection and that, though they possess adaptations which fit them for boring, they are not so highly adapted as the Teredinidae, which are alone amongst wood borers—either molluscan or crustacean—in their capacity for actually feeding on the wood into which they bore.

C. M. YONGE.
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Nomenclature of the Vertebrate Gut.

IT is, of course, well known to all zoologists that certain names have been applied to structures in different animals without due regard to the real significance either of the name or of the structure, with the result that by now these names have lost their definiteness and with it their scientific utility. This is particularly the case of certain terms used to designate parts of the vertebrate alimentary canal, and this letter is to ask for criticism upon the following attempt to clear up at least part of the matter. Excluding many names which still have a sufficiently accurate meaning for all practical purposes (although they vary widely in significance, as some are simply topographical, others presume a similarity of function, while others again imply a true homology), I want to focus attention upon the terms 'oesophagus,' 'stomach,' 'small and large intestine,' and 'rectum.'

It is obvious that 'stomach' should only be

applied to that part of the canal, whatever its shape, where the typical simple tubular (gastric) glands are present. In it should be included the pylorus, the part, long or short, characterised by the great development of the circular muscle layer; but oesophagus should be strictly segregated. If 'stomach' only means, as seems usual at present, an expanded part of the canal in this region, we need a term to apply to the region when it is not expanded and, in addition, we have to talk about part of a 'stomach' being a 'true stomach' and about 'stomachs' being partly oesophageal. After all, there should at least be one name for each functionally distinct part, unless two or more of such parts are always found in combination, and here we are actually one short. So this is the solution I propose: Stomach to be as defined above, oesophagus to be the part between the pharynx and the stomach, crop or ingluvies to be an expansion of the oesophagus, and a new term, oesogaster, to be applied to an expansion of the posterior part of the oesophagus combined with the stomach: this oesogaster may be simple, like that of the Polypterini, or complex like that of the Ruminantia. By this means all the names would, I believe, have a really useful application.

Let us now consider the other three names. The differentiation of the intestine into 'small' and 'large' took place at the time when so many other fundamental changes occurred in the anatomy of the vertebrata, *i.e.* when they took to life on land. It was as necessary to develop a 'large intestine' as to substitute a pulmonary for a branchial method of respiration, because the conservation of water became an essential item in the economy of the individual. So the intestine lengthened, a hinder portion lost its digestive function so as to specialise in absorption, and the differentiation of the 'large' and 'small' intestine was thus brought about. In the higher forms these two parts have elongated and undergone further differentiation, so that more names have been found useful, but these should not be applied to parts of the lower forms. 'Rectum' (the name applied to that last portion of the large intestine concerned with the preparation of the intestinal contents for defaecation) should therefore not be used as a synonym for 'large intestine,' and the latter name should not be applied to the post-valvate portion of the intestine of fish.

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An Improved Mercury Vapour Trap.

INGRESS of mercury vapour from mercury vapour condensation pumps into systems undergoing evacuation is prevented in practice by freezing out the mercury vapour in liquid air-cooled traps. The chief drawbacks to this method lie in the cost of liquid air and in the need of attention in replenishing the liquid air as long as the trap is required to remain in action.

Hughes and Poindexter (*NATURE*, vol. 115, p. 979; 1925) described an alternative method of trapping mercury vapour by means of thin films of distilled alkali metal, either sodium or potassium. This method, whilst probably as efficient as freezing out by liquid air, suffers from the disadvantages that the surface of the metal soon becomes clogged, particularly with large pumps, and that renewal of the alkali metal film involves distillation of the metal; a process destructive of glass or silica apparatus.

During the last ten months I have used with complete satisfaction a liquid alloy of sodium and potassium in order to trap mercury vapour. The

alloy is prepared by melting together, in an inert atmosphere, sodium and potassium in the proportions 1 to 2. The liquid alloy is then poured through a tap funnel into the trap, filled with an inert gas, and consisting of a twelve-inches long wide-bore glass tube provided with inlet and outlet tubes for attaching to the pump and vessel undergoing evacuation. Oxides and scum remain in the tap funnel, clean alloy alone passing into the trap.

Mercury vapour is retained by the alloy in the form of a solid amalgam which collects on the surface of the alloy. The latter may be oxidised to a considerable extent before its powers of retaining mercury fall off to any considerable extent. Regeneration of the alloy surface can be simply effected either by shaking the trap and thus causing cracks to develop in the surface layer of amalgam or oxide, or, better, by sweeping the alloy surface free from such layers by means of a ball or coil of iron wire originally inserted into the trap and moved about therein by means of an external electro-magnet.

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Dug-out Canoe in Algoa Bay.

THE canoe found on the shore of Algoa Bay and illustrated in Mr. FitzSimon's letter in *NATURE* of May 21, p. 746, differs in several respects from those of the Mawken or Selungs of the Mergui Archipelago. During many months spent among those people, I do not remember ever to have seen a Mawken canoe, a kabang, in which the solid hull, apart from the palm stem bulwarks, did not have a gradual sheer from amidships upwards to bow and stern. But more important still, the Selung kabang has a semi-circular notch cut out of the prow and stern of the hull. These form steps by which it is safe and easy to climb into the canoe from the water. I feel sure that whatever may be the origin of the canoe found in South Africa, it did not come from the Mergui Archipelago.

R. N. RUDMOSE BROWN.

The University, Sheffield,
May 23.

I WOULD suggest that, in order to find the home of the canoe which Mr. F. W. FitzSimons discovered on the beach of Algoa Bay (*NATURE*, May 21, p. 746), it is scarcely necessary to look across 5000 miles of ocean. Canoes of this type, with two upturned ends, are commonly carried as tenders by the many Arab dhows which trade along the northern part of the east coast of Africa and from Port Sudan to Zanzibar—and also along the west coast of Madagascar; very similar canoes, either with or without outriggers, are ordinarily employed by the local fishermen.

A model of one of these dhows' canoes may be seen in the Ship-Model Collections of the Science Museum, South Kensington, and if viewed from the direction in which the photograph of the Algoa Bay derelict was taken, it shows a very close similarity in shape. Owing, however, to the derelict having lost the light wash-boards which served to heighten its sides, the photograph gives an appearance of less depth amidships and of exaggerated height at bow and stern.

Instead of the upturned bow of the Algoa Bay canoe, the typical canoes of the Mergui Archipelago are built with the projecting bow, suggestive of the ram of late nineteenth-century warships, which is so commonly seen on the Irrawaddy.

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Rigidity and other Anomalies in Colloidal Solutions.¹

By EMIL HATSCHKE.

THE technical definition of the term rigidity is arrived at by considering a cube of an elastic solid one face of which is held while a tangential force is applied to the opposite one. The cube undergoes a deformation called a 'shear' and resists it by virtue of a property called its rigidity, which causes it to return to its original shape when the force ceases to act. The terms of the experiment lead to a quantitative expression, the modulus of rigidity, that is, the force which, applied to a cube of unit dimensions, would produce unit deformation.

In a transparent isotropic material, such as gelatin jelly, a further change accompanies the deformation: the material becomes double refracting. This accidental double refraction is easily observed in polarised light and is a delicate means of detecting strains in transparent media.

It must be added that the rigidity of a perfectly elastic material does not vary with time, so that the stress required to maintain a given deformation remains constant.

Rigidity is one of the most characteristic properties of the solid state and absent in all normal liquids. The difference between solids and liquids is best realised by considering the ideal case of a liquid between two indefinitely extended parallel planes, one of which is fixed. If now a force, however small, is applied to the other, it moves, not only a small distance as with the elastic solid, but also continuously so long as the force acts and comes to rest when it ceases to do so. The force required to maintain a given velocity is proportional to the area of the plates and the velocity gradient, that is, the velocity of the moving plate divided by its distance from the fixed one, and depends on the viscosity of the liquid. A quantitative expression again suggests itself from the terms of the mental experiment: the force per unit area required to maintain unit velocity when the plates are unit distance apart; this is called the viscosity coefficient. In all liquids it decreases with rising temperature.

A very remarkable feature of this physical constant is that in all normal liquids it is quite independent of the velocity gradient. If all else is kept constant, the forces required to maintain two different velocities are exactly proportional to these velocities.

Instead of expressing the viscosity coefficient in the absolute units of the definition, it is customary in work on solutions, such as we shall consider, to express it as 'relative viscosity,' the viscosity of a standard liquid, generally the solvent itself, being taken as unity. Thus the relative viscosity of a 60 per cent. solution of cane sugar at 20° is 56.5.

Since a normal liquid yields at once to the smallest force, no deformation can be set up in it, nor the accompanying phenomenon of double refraction.

Attempts to detect such an effect at very high shear gradients were first made by Kundt in 1881, and afterwards by other physicists, with negative results except in a few liquids which we now know to be colloidal solutions.

The arrangement of two parallel planes with liquid between them, from which the definition of the viscosity coefficient was deduced, is not realisable experimentally. We can, however, without materially altering the conditions, so to speak 'roll up' the two planes, and confine the liquid between two coaxial cylinders, the outer of which is rotated while the inner is at rest. Such an arrangement can be used for measuring viscosities and will be referred to again.

Historically, it is not the first device used for this purpose. The study of viscosity was begun by Poiseuille, who in 1841 discovered empirically the law, called after him, which governs the flow of a liquid through a capillary tube. This 'transpiration method,' as it was originally called, attracted the interest of Thomas Graham, the founder of colloid chemistry, who applied it to many colloidal solutions. He was so much struck with the changes in viscosity caused by the addition of electrolytes or by mere ageing, that in his famous paper on silicic acid he made the often quoted remark that "a liquid transpiration tube may be employed as a colloidoscope."

The transpiration tube, or, as it is now called, the capillary viscometer, was used by a large number of observers, generally in the simple form given it by Wilhelm Ostwald, in which the pressure causing the flow of liquid is produced by a column of the liquid itself. As measurements accumulated it became evident that many colloidal solutions did not behave like normal liquids, but the instruments in general use were theoretically inadequate to reveal the nature of their anomalies. On a somewhat different footing stands an investigation by Garrett, published at Heidelberg in 1903. He studied the viscosity of a number of colloidal solutions both in the capillary and by a method not used before. If a circular, horizontal disc suspended from a wire is made to oscillate round its axis in a liquid, the viscosity coefficient can be calculated from the damping effect. Garrett found in this way that colloidal solutions exhibited a number of bewildering anomalies. The values found by the disc method did not agree with those determined by the capillary; they were not even consistent among themselves, but varied with the amplitude of the oscillations and altered even during the course of the experiment. This investigation is quoted in all the text-books published about 1910 to show the complexity of the problem, but no very definite attitude towards it is taken up by the authors.

The first deliberate attempts to bring some light into the matter were made about this time by Prof. W. R. Hess, of Zürich, and by myself, working

¹ Discourse delivered at the Royal Institution on Friday, Mar. 18.

in ignorance of each other. Hess had been induced to attack the problem by practical considerations: measurements of the viscosity of blood had become a clinical method, but the results obtained by various observers were difficult to reconcile. Hess showed in an improved capillary viscometer that the viscosity of blood and of some colloidal solutions like gelatin was not a constant but varied with the shear gradient; the faster these liquids were sheared the less viscous they appeared to be, until above a certain gradient the viscosity coefficient became a constant.

In a theoretical paper published early in 1911, I had reached the conclusion that colloidal solutions of a certain type should have a variable viscosity which should become constant above a certain velocity gradient. I proceeded to test these conclusions in a modification of the concentric cylinder apparatus which was first used by Couette in 1890.

This apparatus consists of an outer cylinder, which can be rotated at constant speed, and an inner cylinder coaxial with it and suspended from a wire. When the outer cylinder revolves, the viscous drag of the liquid carries round the inner one, until the torsion of the wire balances this drag. If all end effects are eliminated—which can be accomplished by screening the ends of the inner cylinder by suitable fixed guards—theory shows that the deflexion of the inner cylinder, which is read with telescope and scale, is exactly proportional to the product of angular velocity into viscosity.

The first results obtained with this apparatus were published in 1913. Dilute gelatin solutions were investigated, and the viscosity was found to decrease rapidly with increasing velocity: at 10° per sec. it was about 2.5 times as great as at 100° per sec. The curves representing the variation of viscosity with velocity all show a tendency to become horizontal at high velocities, and to rise asymptotically at low velocities. The same behaviour has been found in a very large number of colloidal solutions, examined either in the concentric cylinder apparatus or in improved forms of the capillary instrument, in which the rate of flow can be varied. In a few instances apparent exceptions have been found by some observers, i.e. viscosities which appeared to be constant. These discrepancies have been cleared up by extending the range of investigation to much lower velocity gradients, when the usual behaviour could be demonstrated again. Increasing viscosity with decreasing shear gradient may now be considered a general property of colloidal solutions.

Since this behaviour is thus characteristic of a large and important class of liquids, and in the most striking contrast to that of normal liquids, it is of great importance to find some explanation of it. One suggested by several authors, including Prof. Freundlich, is that these solutions, unlike normal liquids, possess rigidity as well as viscosity. It can indeed be shown mathematically, by making the simplest assumption regarding this rigidity, that the result will be what has been

found experimentally, namely, decreasing viscosity with increasing velocity gradient.

The suggestion that solutions which nobody could hesitate to describe as liquids should possess one of the fundamental properties of solids is so surprising, that one is naturally anxious to have a direct demonstration rather than an inference from mathematical treatment. There is no difficulty in providing this demonstration with delicate apparatus, which permits measurements of the modulus to be made. I have, however, been fortunate enough to discover a solution, the rigidity of which can be demonstrated without any apparatus at all, namely, dilute ammonium oleate. If a freshly prepared solution is given a rotary movement in a beaker it gradually comes to rest like any other liquid, but then *rotates backwards*.

The ammonium oleate solutions are mechanically very labile systems, the elastic properties of which depend on their age and previous treatment. In view of their marked rigidity they appeared to be excellent test objects for the assumption that it was this property which caused variable viscosity. Examination, however, revealed the further striking anomaly that these solutions had viscosities which varied even at constant velocity gradient and oscillated periodically between well-marked maxima and minima.

This anomaly fortunately is unique, although a decrease in viscosity after continued shearing is quite common. As regards rigidity, no other solution so far examined shows it in the same striking manner as ammonium oleate, and special apparatus is necessary to demonstrate it and to measure the modulus. The first measurement of this kind was carried out by Schwedoff in 1889 on a 0.5 per cent. gelatin solution; a series of such solutions was investigated by Rohloff and Shinjo at Göttingen in 1907. We were desirous of studying solutions other than gelatin, more especially those which had shown markedly variable viscosity, and employed Schwedoff's method for the purpose.

This method again uses the artifice of confining the liquid between concentric cylinders, the inner one being suspended from a wire. If now a certain torsion is given to the wire, and if the liquid between the cylinders is merely viscous, the suspended cylinder begins at once to follow the wire and continues to do so, until no torsion is left in the wire. If, however, the liquid has rigidity, the cylinder does not follow, but describes a much smaller angle than that by which the wire has been twisted, and remains in this position for some time, the rigidity of the hollow cylinder of liquid now balancing the torsion. From the two angles and the constants of the apparatus the modulus of rigidity can be calculated.

All the liquids we have examined lose their rigidity at or below 40° , and, to obtain a satisfactory zero, they are charged into the apparatus at this temperature and allowed to cool in it for twenty-four hours before measurements are made. The moduli are of the order of *milligrams per sq. cm.*, whereas the modulus of 10 or 12 per cent. gelatin jellies is about 100 grams per sq. cm. and that of metals

of the order of tons per sq. cm. Solutions of ammonium oleate, gelatin, benzopurpurin, and cotton yellow (two dyes), and of mercury-sulphosalicylic acid, have been studied in this fashion. In all of them the modulus increases with age; a corresponding increase in viscosity has been known to occur for some time.

Since these liquids can support a small deformation, one may expect them to exhibit accidental double refraction, and they all do so, though in very different degrees. The phenomenon is most strikingly shown by quite dilute solutions of cotton yellow and of mercury-sulphosalicylic acid, when they were stirred or caused to flow. This accidental double refraction disappears with the rigidity on heating.

Although the solutions described exhibit measurable rigidities, the properties of the liquid state yet manifest themselves inasmuch as, unlike elastic solids, they do so for a short time only; very soon the phenomenon called by Maxwell 'relaxation' sets in and, in the apparatus described, the inner cylinder gradually follows the wire. From the constants of the apparatus and the time required for a given angular displacement the viscosity of the liquid at extremely low velocity gradients can be calculated; a number of determinations have been made at speeds which correspond to one revolution of the viscosity apparatus described above in 7.5 days; while the lowest speeds so far used have been of the order of one revolution in 2.5 minutes. At these very low velocity gradients the relative viscosities (water = 1) approach 100,000, which confirms the result of a very large body of measurements at ordinary gradients, namely, that the viscosity with decreasing gradient grows asymptotically and at infinitely small velocities really becomes infinite.

We thus have a considerable body of evidence for the existence of rigidity in many of the solutions which exhibit anomalous viscosity, and numerous series of measurements of the latter over a wide range of velocity gradients. As regards the causes of these anomalies we are still in the dark, although there has been no lack of the *ad hoc* hypotheses which are characteristic of a vigorously growing discipline like colloid chemistry. To explain the anomalies it has been suggested that the particles forming these solutions have peculiar shapes and arrange themselves in a special manner; although the particles are of much larger than molecular sizes, they are yet supposed to be modelled on the shape of the molecule. Thus the long chain molecules of the fatty acid salts, or the long chains of amino-acids forming proteins like gelatin, are assumed to produce filamentous aggregates or ramifying structures. There is little direct evidence of such structures, since most of the solutions in question show no particles in the ultra-microscope, and the extreme chemical diversity of the substances the solutions of which show anomaly makes the explanation at least inadequate. While compounds like the oleates undoubtedly have long chain molecules, the mercury-sulphosalicylic acid

is a very simple aromatic compound of a type which makes chain formation difficult to conceive.

It is, however, not only the extreme diversity of chemical structures which makes such attempts at explanation unconvincing, but also we have experimental evidence showing beyond any doubt that variable viscosity can be produced by simply suspending in a normal liquid a small volume percentage of microscopic particles of nearly spherical shape. I showed in 1916 with Dr. Edith Humphrey (and the measurements have since been repeated and extended) that such suspensions (of rice starch in an indifferent organic liquid of the same density) exhibited viscosities which varied with the velocity gradient exactly as do the viscosities of colloidal solutions: with decreasing velocity the viscosity grows asymptotically, while with increasing velocity it approaches, and in the lower concentrations reaches, a constant value.

There is no evidence, and certainly no probability, that such particles aggregate into chains, and the cause of the variable viscosity must therefore be sought, not in their configuration, but in some effect which they produce on the surrounding liquid. There is a very large amount of evidence drawn from the most diverse phenomena to show that particles in a liquid are surrounded by films or layers of it in which the properties of the liquid are altered. The viscosity measurements on suspensions suggest that these layers must extend some distance into the bulk of the liquid and must be sufficiently labile to be affected by the shearing of the liquid. These considerations would apply to all particles, whatever their shape or arrangement, and the combined effect of these factors would necessarily be complicated.

There is a further strong argument for the view that the cause of the anomalies of these solutions has to be sought partly or largely in some change in the solvent, and that is the striking uniformity of their behaviour regarding temperature. Solutions of substances differing as widely as possible in their chemical constitution behave alike, inasmuch as they lose their rigidity about the same temperature, namely, 40°. It seems natural to look for the reason of this uniformity in the factor common to all the solutions, the water, for the properties of which this temperature is significant.

There is no doubt that the anomalies here discussed have an important bearing on processes in organisms, all of which consist largely of colloidal material. It is impossible to enter on so vast a subject, but attention must be directed to the general physical aspect of rigidity and variable viscosity in colloidal solutions. It is known that under enormous pressures solids behave like liquids, *i.e.* flow; colloidal solutions exhibit the converse behaviour: under exiguous stresses they approximate to the behaviour of solids by exhibiting rigidity and enormous viscosities. Many of them pass continuously into jellies which, within limits, behave more and more like elastic solids, and these colloidal systems thus provide a remarkable series of transitions from the liquid to the solid state.

The Progress of Hittite Studies—II.¹

By Prof. J. GARSTANG.

THE new documents bearing on home affairs, though numerous, are not easy of interpretation. It is known from a cursory examination of more than 2000 fragments that the subject matter includes kings' speeches, chronicles and decrees, wills, deeds of gifts and patents of nobility, treaties, legal agreements, inventories (both civil and military), registers of landed property, codes of law as well as detailed military regulations. A large proportion deals with religious matters, including descriptions of festivals and ritual; prayers and legends; questions for the oracles, soothsayers' texts, incantations, and so forth. There is evidently material for reconstructing the social institutions and organisation of Asia Minor under the Hittite kings that will in due time become intelligible. Already, notwithstanding the difficulties of language, the nature of the kingship and government, and the military organisation of the confederated states may be discerned in outline with a measure of certainty.

The Hittite kingship was essentially military, and it was established on a feudal basis. All lands and offices were received from the king on terms of service, whether military or civil. All officers and functionaries were sworn in to personal loyalty, from the viceroy to the royal shoemaker. In the wider aspect of the Great-King as head of the vassal or allied Hittite states, the same principle prevailed. Each king or chieftain owed military service to the central throne, whether by way of levies to the standing army or terms of special service. When princes were enthroned or re-enthroned after revolt, the terms of service were defined by treaty. This applied to conquered territories of non-Hittite or not purely Hittite peoples. Thus the kingdom of Arzawa on the southern coast, which appears frequently opposed to Hittite rule, was dismembered by Muršili III. after one such revolution, and each state was separately bound by agreement to fealty and military obligations. In the time of imperial domination over the states of northern Syria (the fourteenth and thirteenth centuries B.C.) the duties of each vassal in regard to the Great-King's wars were defined and their relations towards one another were dictated to them. The powerful Amorite rulers of the Lebanon area were treated with a certain measure of respect, but even they were bound to join their forces to the Hittite armies in the greater enterprises, and among these the possibility of a conflict with Egypt was foreseen.

While the king's position as head of the army was absolute, and his dominion over the vast agglomeration of Hittite states and conquered territories was maintained by a ready sword, yet in the conduct and organisation of military affairs there was an accepted procedure and code of regulations. The position, rights, and duties of the army, its units and its leaders, were carefully and

strictly defined. Army orders covered all such questions as the requisitioning of private property, reservation of quarters, lodging of prisoners, guard duty, the construction of camps—even to the detail of the dimensions of ramparts and ditches and the length of palisades when encamped in enemy country. It is also noteworthy that proper personal credit is given to the generals and officers. A sense of social equity pervades the records, in which the historical sense was equally impartial, no difference being seen in the narrative of events whether to the glory of the king or of his generals, or even when revealing the weakness of either.

This sense of equity finds its official expression in the constitution of a general assembly to advise the king on questions of law and constitutional procedure. The princes of allied and vassal states had their places at this meeting and many of them held high office or high titles at the court itself. The system permeated the administrative organisation of the land: each principality had its local assembly and each township its council of elders. The constitutional history of the later empire suggests, in fact, the presence of the same tendencies, and much the same processes at work, as later in early England.

By the side of the military absolutism, modified by gradual infiltration of democratic principles, there is always visible a theocratic element of power around the throne. The king was hereditary High Priest of all the gods. His duties and functions at the chief rites were formulated and are preserved. Before and after his campaigns the young warrior Muršili III. never failed to invoke the blessing of the sun-goddess of Arinna, the maker and dethroner of kings, mistress of oaths, and goddess of war—and to render to her all the glory of his successes. This duty was not self-imposed. A deep religious sense permeates numerous documents and was evidently a national heritage, and an offence against the gods might involve national disasters. Some of the latest documents reveal this element most strongly, and in several parts of Asia Minor, as is well known, the theocratic system survived the military kingship. Until earlier documents give their evidence it is not possible to say whether this tendency was a new and growing one, or whether, as would seem more likely, the military rule of the Hittite kings was originally imposed upon a theocratic society, of which, as in religious worship, it assimilated the strongest elements. It is significant that while the duties of the priests were laid down in detail, they were restrained from holding property of any kind except by royal gift and favour.

In regard to the organisation of the land, with its numerous principalities and fiefs, there are many important documents of which the full interpretation is not yet possible because the geographical names are unfamiliar. The outline of the picture is clear but the detail is confused.

¹ Continued from p. 820.

The interpretation of documents relating to foreign affairs has been greatly facilitated, not only by the Semitic language of the texts but also by the fact that names of places in the Semitic world are in some cases permanent or at least transparent. An immediate example of survival is the name of Aleppo, namely, Ḥalab, or Ḥalpa, which is essentially the same to-day, and was so in Egyptian. In other cases tentative identification based on similarity of sound or general indications of position can be checked by comparison with parallel documents from Egyptian or other sources. Thus the name Yaruwaddaš (written also Yaruwandaš) scarcely disguises the name of Arvad, Egyptian Aruad, the island city near modern Tripolis on the coast of Syria. The equation is confirmed by reference to the Amarna letters, in which the same persons and situations are mentioned as in Hittite documents. Working on these lines, certain points may be fixed (e.g. Kinza = Kodshe = Kadesh), so that narratives of campaigns may be followed on the map, and in so doing other identifications can be tentatively formulated with due regard to the physical and political geography of the areas involved.

The documents concerning Asia Minor, however, contain hundreds of place names which have not survived the various changes of race and language, and except for the capital itself (the name of which has also disappeared), there is scarcely a fixed starting-point upon which students are agreed. The few maps published by German scholars accordingly show profound and disappointing differences. Nevertheless, possible clues may be found in the grouping of the names, having regard to the physical features of the country, and the possibility of some surviving sound-elements in classical or Turkish names. Thus a town Wi.ya.na.wa.an.da, grouped with a river Aštarpa, which is a boundary of a district Kuwalia, with which in turn there is associated a boundary River Siyanti and a tract called Mira, suggest respectively the Lycian Oeneanda (the digamma disappearing), the River Isparta (an assimilation by metathesis to a local and relatively recent place name), the district of Kabalia (the digamma this time becoming β, a tendency noted by Ramsay, *H.G.* p. 22), together with the Eshenide River or Eshen (classical Xanthos) and the district of Milyas (Lycian Mira). This grouping in Lycia accords precisely with the indications of physical and classical geography; but Dr. Forrer, whose line of attack is different, places the same group in the east of Cilicia, where also was a classical name Oeneanda. In the latter district, moreover, some English scholars would locate an entirely different state called Kizzuwadna.

Another group of Hittite names, from a list of hiera, which is several times repeated with variations, associates:

Dunna . . . Ḥubišna . . . Tuwanuwa . . . Laanda and Maššuhanda.

With these may be compared the Cappadocian group from Ptolemy (Cataonia, etc.):

Tynna . . . Kabassos (? Kybistra) . . . Tyana . . . Leandis and Mazaka.

The identity of Tyana is generally admitted; and

the suggested identity of Maššuh-anda with Mazaka recalls the tradition that its founder was Mošoḥ (cf. Meshekh), which may account for the composition of the Hittite name. In this way, group by group, a working theory of the identity of the Hittite places, and so of the disposition and military organisation of the Hittite states, can be constructed. In it a number of names appear to survive plausibly; e.g. Alše as the Assyrian Alze (Arzen); Damašhunaš as Damascene; Ḥumiššenaš as Komisene; Kuššar, of which the variants are Kuššara and Kuššaraš, and the latest form apparently Gaz-zi-u-ra-aš, as Gaziura (Strabo xii. iii. 15); Kuwanna as Kuwania (Konia); Teburzia as Trapezus (Trebizond); Urušša as Eriza; Zimurria as Zimara, etc. The result shows the main political divisions which are based upon physical features to have been permanent. Thus the central Ḥatti state is represented generally by Cappadocia; the allies of Arzawa and Kizzuwadna reappear as Cilicia and Pontus respectively, Gasga as Lesser Armenia; while the rival state of Ḥarri was the forerunner of Armenia, east of the Euphrates.²

In general it may be argued that the power which resisted for centuries the old monarchies of Egypt and Babylonia and occasionally challenged them in Syria was presumably master of all Asia Minor. In particular the control by Ḥatti of the passes of anti-Taurus towards the Euphrates and Syria may be assumed; and the general resemblance of the Hittite monuments, borne out by comparison of details, may be adduced in support of the view that nearly all the monuments characterised as Hittite by special hieroglyphs or symbolism throughout south-east Cappadocia and anti-Taurus (including the palace sculptures of Marash and Malatia) are Hittic in inception. The result indicates a strategic organisation of the south-east frontier which is accordant with its physical features and the course of history.

Turning to the rest of Asia Minor, the names in the north-west are more baffling than elsewhere, possibly owing to the Phrygian and other historical immigrations. But the line of monuments along the main highway from the capital to the coast near Ephesus, is evidence of an extension of Hittic dominion to the Ægean, at a time more or less contemporary with the religious sculptures of the capital.

The menace and gradual penetration of the Achæans on the western and southern coasts provides further evidence that the later Hittic kings regarded these tracts as within their dominion. The attempts of the newcomers to settle on the Carian coast in the thirteenth century have been indicated by Dr. Forrer. In amplification of his thesis, we may point to a group of names mentioned in connexion with the expedition by sea with 100 ships of Attarišiyaš (who is identified tentatively with Atreus by Forrer, and with Perseus by Sayce). Among these names (Wallarimma, Ialanti, Bitāšša, Maraša, and Millawanda) there appears the unusual form Khuršunašša, which seems to equate perfectly

² For a fuller discussion and map, cf. "Index of Hittite Names" (Sp. Publ. of the British School of Archaeology in Jerusalem).

with Khersonesos, and so to give a clue to the identity of the whole. Accordingly the following possible identifications may be suggested, following the same order: Hillarima, Alinda, Pedasa, Mylasa, and Miletos respectively. The last is based on the analogy and variant forms of Yaruwaddaš. If these equations stand test, it would appear that the coast at any rate preserved its Hittite names remarkably, unless indeed the texts are quoting names which, as in Syria, were new or foreign to the Hittite scribes.

However that may be, two further points respecting the Achæans' movements may be mentioned. Repulsed from Caria, they gained a footing in Cyprus about 1226 B.C. Almost immediately they are found in company with Trshu and Luku, as well as Shekelesh and Sherdenu, raiding the Egyptian coast in the time of Merenptah. Their base in Cyprus explains the association about which there has been much uncertainty, suggesting a local geographical group in which the Akwesh (Achæans from Cyprus) are combined in this adventure with peoples from Tarshish and from Lycia, as well as others possibly from Sagalassos and from Sardis.

Lastly, it is becoming apparent that these texts connected with the Achæan penetration are

gradually unfolding the background for the Trojan War. For in the time of Mutalliš (c. 1288) various new peoples with Trojan names, Derden, Luka, Pedes, Kelekesh, and others, are found newly leagued with the Hittite king against the Pharaoh. About the same time appears the name of Alakšanduš as an ally of the Hittite and settled by treaty at Uiluša (? Elaeusa). Greek legend also tells how Paris on his return from Egypt and Syria (according to one version of the story of Helen) was hospitably entertained by the 'Assyrian' king 'Motulos.' Whether this prove relevant or not, there is definite indication in these records that while the Achæans were menacing by sea the western and southern coasts of Asia Minor, the Dardanians were already being accepted as allies by the monarch and peoples of the mainland. The clash of arms around Troy (which by name Taroisa already appears in the texts) was but one crisis in the struggle which heralded the downfall of the Hattic empire. For long critical centuries European civilisation and society had been taking shape, protected by the Hittite organisation in Taurus and Anti-Taurus against the older ambitious monarchies of the Euphrates and the Nile. With the rise of the Iron Age, when Europe was able to fend for itself, the old Hittite barrier gave way.

Obituary.

PROF. EDOUARD BRÜCKNER.

THE death of Prof. Edouard Brückner at the age of sixty-four years, which took place at Vienna on May 21, removes a figure well known to both meteorologists and geologists. Brückner was born at Jena on July 29, 1862, his father being Alexander Brückner, the historian, which may account for the historical bias of his early meteorological work. He received the degree of Ph.D. at Munich in 1885, and from 1886 until 1888 he acted as assistant editor of the *Meteorologische Zeitschrift*. It was during this period that he discovered the weather cycle of 35 years which is universally known as the Brückner Cycle. During the next two or three years he collected a great deal of statistical evidence in support of this cycle, which he published in 1890 under the title: "Klimaschwankungen seit 1700," now one of the classics of meteorology.

Brückner's life-work was not mainly meteorological, however, for in 1891 he became professor of geography at Bern, and in 1906 professor of geography at Vienna, and although he continued to publish occasional meteorological papers so late as 1918, the main interest of the second half of his life was in the Quaternary history of the Alps, a subject in which he collaborated with Albrecht Penck. The fruit of this collaboration was a series of three large volumes, containing 1199 pages, published between 1901 and 1909—"Die Alpen im Eiszeitalter." To appreciate the service which this work did for glaciology, one must consider the position of the science in 1900. The battle between the supporters of one and of several glacial periods still raged hotly, the nomenclature was confused, and the wildest ideas of chronology prevailed. The

thoroughness and minute detail of "Die Alpen im Eiszeitalter" decided the battle in favour of the polyglacialists, laid the foundations of a sound chronology, and provided a standard of reference and nomenclature which, by the general acceptance it compelled, has rendered incalculable assistance to glaciology in all parts of the world.

DR. VIKTOR ROTHMUND, professor of physical chemistry in the German University at Prague, died on May 10, at the age of fifty-seven years. A native of Munich, Rothmund was appointed to a lectureship at the University of Munich in 1898, which he held until 1902, when he was appointed to the chair at Prague. His published papers deal with a variety of subjects, including solubility, ozone, hydrogen peroxide, perchlorates, permutit, and the passivity of metals.

WE regret to announce the following deaths:

Dr. Carl H. Eigenmann, professor of zoology and dean of the graduate school of the University of Indiana, known for work on the variation, distribution, and embryology of fishes, on April 24, aged sixty-four years.

Prof. W. Lochhead, emeritus professor of biology in Macdonald College, McGill University, known for work on insect and fungus pests of orchards, on Mar. 26, aged sixty-two years.

Mr. W. H. Shrubsole, who worked on modern and fossil diatoms and related forms and was awarded the Lyell Fund of the Geological Society in 1898, on May 19, aged eighty-nine years.

Prof. William Carleton Williams, professor of chemistry at the University of Sheffield from 1883 until 1904, on May 25.

News and Views.

THE list of honours conferred by the King on the occasion of his birthday on June 3 includes the following names of men of science and others associated with scientific work: *Order of Merit*: The Hon. Sir Charles Parsons, in recognition of his eminent services in scientific research and its application to industries. *G.B.E. (Civil Division)*: Sir Frank Heath, until recently Secretary to the Department of Scientific and Industrial Research; and Sir Richard Threlfall. *K.B.E. (Civil Division)*: Dr. C. E. Ashford, Headmaster of the Royal Naval College, Dartmouth. *Knights*: Mr. W. G. Lobjoit, until recently Controller of Horticulture, Ministry of Agriculture; and Prof. C. J. Martin, Director of the Lister Institute, London. *C.M.G.*: Prof. R. W. Chapman, professor of engineering in the University of Adelaide. *C.I.E.*: Mr. A. G. Edie, Chief Conservator of Forests, Bombay. *C.B.E. (Civil Division)*: Mr. D. J. Davies, Government Analyst, Department of Public Works, Newfoundland. *O.B.E. (Civil Division)*: Mr. G. W. Grabham, Government Geologist, Khartoum; Mr. T. F. Main, Deputy-Director of Agriculture, Bombay; and Mr. V. E. Pullin, Director of Radiological Research, War Office.

THE new Science School at Clifton College, an account of which is given on p. 871 of this issue, was formally opened on Thursday, June 2, by H.R.H. The Prince of Wales. The boys gave a rousing welcome to their distinguished visitor, who was received at the Memorial Gate by the president of the College (Field-Marshal Lord Haig) and the headmaster. After lunch in the School House, the Prince proceeded to a dais outside the new building, where he made a felicitous reply to short speeches given by the president and headmaster. Referring to his presidency of the British Association, he said that it had brought him into touch with what was more or less a new world to him—the world of science—and had given him many new interests and new contacts. In declaring the new building open, he expressed the hope that it might prove the cradle of many future men of science—of future Faradays, or Kelvins, or Tildens—who would win further laurels for British learning and confer on all humanity benefits equal to those conferred by these great men in the past. He also laid emphasis upon the value of some training in science even to those who in later life were not to embark upon a professional scientific career. A number of presentations were then made, including representatives of the donors, the architect (Mr. Alan E. Munby), the head of the department (Mr. E. J. Holmyard), and the head of the physics department (Mr. W. C. Badcock). Many distinguished representatives of science and other branches of learning were present, and they were much interested in the display of books in the fine library in the new building, where an exhibition had been arranged. Clifton is fortunate in possessing the copy of Dalton's "New System" formerly belonging to William Henry, to whom the book was dedicated; a copy of

Tyndall's "Faraday as a Discoverer," presented to Mrs. Faraday by Tyndall himself; a copy of Cannizzaro's works presented to Victor Meyer by the author; a copy of Avogadro's "Fisica" with an inscription in the author's hand; and first editions of Newton, Boyle, and Galvani. It also has a large collection of books on alchemy and early chemistry, so that if Clifton does not rear a succession of historians of science it will not be through lack of early opportunity.

A SURVEY prepared by Science Service of the recent legislative season in the United States discloses what appears to be a temporary collapse of the great anti-evolution drive in the various State legislatures. During the past winter and spring no less than twelve State legislatures had anti-evolution bills brought before them and all twelve have adjourned without the passage of a single one of the measures. In six of the States—California, Delaware, Minnesota, New Hampshire, North Carolina, and North Dakota—the bills did not even reach the floor of their respective Houses, but were disposed of in committee by decisive or unanimous votes. In Missouri, declared to be a pivotal Fundamental State, the bill reached the House, but was there rejected by 82 votes to 62. In West Virginia and Oklahoma similar bills were defeated by House votes of 57 to 36 and 46 to 30 respectively. An aggressive campaign in Arkansas resulted in an anti-evolution bill passing the lower house by a very close margin, but it was rejected in the Senate by an overwhelming aye-and-nay vote. In two States, Alabama and South Carolina, anti-evolutionist bills have been temporarily shelved. In Florida, where the legislature meets later in the year than in other States, a bill is at present being hotly debated, predictions being that it will not pass. In Tennessee, one of the two States where an anti-evolution bill has become law, there prevails considerable doubt amongst legal authorities as to its interpretation; and in Mississippi the law has not yet been tested in the courts.

THE Education Association of the Southern Methodist Episcopal Church in the United States has condemned the anti-evolution legislative programme. The resolution was introduced by the president of Duke University, one of the largest and most influential of southern educational institutions, and only two delegates voted against it. Prominent southern Baptist churchmen have also declared themselves as opposed to legislative restrictions on teaching. All the other churches have fought this wave of obscurantism virtually from the start; but the southern Methodists and southern Baptists are by far the most numerous bodies in the American south, and their attitude is highly significant. On the whole, in spite of a new movement recently set on foot to organise local opinion against the appointment of 'evolutionist' teachers, or to try to secure their dismissal, the situation seems not unsatisfactory. The future seems to depend upon the ability of the teaching

profession in America to resist what may be called the dictatorship of the illiterate.

A RECENT article published in *NATURE* (April 2, p. 481) on the subject of the scientific slaughtering of animals has elicited an interesting letter from Mr. Herbert Kidd, 331 Franklin Street, San Francisco, contrasting the British and American methods of slaughtering. From this letter it would appear that the subject has hitherto attracted far less attention in America than in some European countries, and that the modern method of the captive bolt pistol is very little used there. Mr. Kidd states that cattle are stunned with a sledge-hammer, the Argentine practice of afterwards pithing with the stem or handle having been abandoned because it involves the loss of about $\frac{1}{2}$ lb. of meat per beast through bruising. Sheep are killed on the floor at the high over-all rate of 6 sheep per man per hour, and the spinal cord is not severed. Mr. Kidd's letter brings out a point which gives a good deal of trouble to those who are concerned about this backward aspect of civilisation, namely, the great variations in local practice which make generalisations on the subject precarious: a standard practice throughout the world of the method which has been found statistically to be the most humane is much to be desired. It would be interesting to know the position as regards small private slaughterhouses in a country where large-scale operations are so common as in America: in England (as contrasted with Scotland) local authorities which have built public abattoirs are unable to work them at a profit because they have no power to close the competing private slaughterhouses, either with or without compensation.

A SMALL booklet has been issued by Mr. Ernest A. Chapman, 69 Hayter Road, London, S.W.2, with the view of further elucidation of four small pearl shells which are not only very peculiar and highly interesting in themselves, but also seem to have had a curious history. The pamphlet is very carefully illustrated with excellent photographs, and any one interested should be able to gain a fairly complete idea of the problem from it. The four shells are really four similar valves, none of them having its partner. Each valve contains a pearl attached to the shell by nacre deposition. It is stated that experts in four continents have been consulted without success, and that eminent conchologists in Great Britain are of opinion that the shells belong to an extinct or unknown species. They have been heirlooms in the possession of a family in the south of Ireland for many generations, but no knowledge is forthcoming of how they reached that family. The names of several well-known experts are mentioned in the pamphlet, and the reader is left with the statement that they regard these little shells as a unique set, the only specimens of the type seen or reported.

PROF. W. J. DAKIN, Derby professor of zoology in the University of Liverpool, has been kind enough to examine the shells on our behalf, and he states that he is not prepared to accept the views put forward in the pamphlet. "It seems rather singular," he says,

"that the four shells should be so like in appearance, and each with a blister of the same large size in the same place. There is also no doubt that the margins of the 'shells' and the hinge lines have been trimmed and polished. It seems probable that the 'shells' are not real in the natural history sense at all, but have been carved from the nacreous part of a larger pearl shell. I do not agree with the statement that the shells are too deep for this: such is decidedly not the case. Neither can it be admitted that artificial work would be more easily detected. It is not fair to compare what an amateur might do with what can be done by an accomplished Oriental worker. There remains to be granted an extraordinary resemblance (indicated by Prof. Morley Davies) to an extinct Miocene species which is depicted in the pamphlet. It is not, however, altogether convincing. Shell collectors and others who have been interested in cameos and curios carved out of mollusc shells might take a hand in solving this tantalising little puzzle."

THE seventh annual report of the British Non-ferrous Metals Research Association shows rapid growth. The total expenditure on research during 1926 was £22,000, and that figure will be increased during the present year. The period of full Government grant has now expired and that source of income diminishes progressively, but sufficient support is being received from the industry to continue the research work on the same scale. It is remarkable, however, that even now prominent firms sometimes fail to take advantage of the scientific results of the investigations and withdraw the support which they have previously given. A study of the report will show that manufacturers have everything to gain by becoming members of such an organisation. Among the investigations which are making good progress and are of general interest are those concerned with the wastage of locomotive firebox stays, in which all railway companies are interested, and the deterioration of lead cable sheathing, which is of importance to the telegraph and telephone industries. Much is expected of the investigations in hand on materials capable of resisting high temperatures, and valuable results have already been obtained in this direction. Researches on electro-deposition and on methods of casting and jointing have engaged the attention of many workers, and the combined researches on die-casting are doing much for an industry which is of growing importance. Among other activities the Association has made a survey of annealing furnace practice, and has been able to advise as to improvements in annealing practice. The report contains much that is of interest to metallurgists in general.

RADIO communication is proving of great value to isolated communities on various parts of the earth's surface. For example, the lonely Farsan Islands in the Red Sea, which are about 400 miles north of Aden and the same distance south-east of Port Sudan, are being examined for oil by the Red Sea Petroleum Company. The prospectors are equipped with an ordinary Marconi ship's transmitter. Through the

neighbouring ports, or through any of the large number of ships within radio range passing up and down the Red Sea, they can easily link up with main telegraph circuits, and also secure, if necessary, medical advice and other assistance.

THE new short wave beam stations enable news to be transmitted to the Dominions much more rapidly than by ordinary radio services. Last year it took sixty seconds to transmit the name of the winner of the Derby to the Melbourne central telegraph office. This year the name of the winner was transmitted in three seconds, and in fourteen seconds after the finish of the race the full result was known in all the principal newspaper offices in Australia. This result was equalled on Budget day this year, only a few days after the beam stations had been handed over to the General Post Office. A thirteen-word 'empiradio' message, giving the first news of the Budget, was transmitted to Australia in thirty seconds.

ON Tuesday, May 24, Mr. J. L. Baird gave a successful demonstration of television between Motograph House, London, W.C.2, and the Central Hotel, Glasgow. Two ordinary Post Office telephone lines were used, one being for conversation and the other for the television transmission. The inventor has simplified the method of synchronising the two machines employed by means of a new arrangement of filter circuits. The telephone lines connecting the two stations were 438 miles long. Possibly owing to induction effects with neighbouring circuits the images were sometimes unsteady, but in most of the experiments they were steady and clear. Instructions given through the telephone to the operator at London were shown by the image to be immediately obeyed. Arrangements are being made to demonstrate television between London and New York.

A NEW observatory on Kilauea—the Uwekahuna Observatory and Exhibition Room of the Hawaiian Volcano Research Association—was opened on April 19 (*Volcano Letter*, April 21). It is intended for the use of visitors, to explain to them in an appropriate setting the mechanism of volcanoes. Built on the highest rim of the Kilauea crater, the view from it includes Mauna Kea and Mauna Loa, the cones of the Kau Desert, and the Halemaumau pit, the latter a great chasm less than a mile away, as well as all the details of the Kilauea crater.

ON June 6, Mr. Clarence Chamberlin and Mr. Levine landed at Eisleben after a non-stop flight from New York of about forty-three hours. Thus Capt. Lindbergh's record for distance and time in the air without landing, set up so recently as May 22 last (*NATURE*, May 28, p. 792), has been broken. Mr. Chamberlin, with Mr. Levine as passenger, started on June 4 at 6.5 A.M. in a Bellanca monoplane, the *Columbia*, and was forced to land at 5.35 A.M. on June 6 by the exhaustion of his petrol supply, after covering a distance estimated at 4400-4700 miles. The machine was fitted with a 200 h.p. Wright "Whirlwind" radial engine and was in other respects similar in type to that used by Capt. Lindbergh.

AN expedition under the leadership of Mr. G. P. Putnam to Baffin Island is announced in a recent issue of *Science* (No. 1689). The expedition will leave New York this month in the schooner *Morrissey*, and will be under the auspices of the American Geographical Society, the Museum of the American Indian, and the American Museum of Natural History. The course is to be through Hudson Strait to Fox Basin, which is one of the least explored parts of Arctic Canada. Most of its eastern coast is still uncharted. Expeditions into the interior of Baffin Island will be attempted. The main aims of the party are the collection of zoological and anthropological specimens.

AT the recent annual meeting of the U.S. National Academy of Sciences, Prof. T. H. Morgan, of Columbia University, distinguished for his work on hereditary processes and evolution in animals, was elected president. Dr. F. E. Wright, of the Carnegie Institution of Washington, was elected vice-president of the Academy, and Dr. David E. White, of the U.S. Geological Survey, was re-elected home secretary. Three new members of council were appointed: Prof. George E. Hale, Mount Wilson Astronomical Observatory; Dr. John C. Merriam, president of the Carnegie Institution of Washington; and Dr. J. McKeen Cattell, editor of *Science* and other scientific publications.

THE following were elected members of the U.S. National Academy of Sciences at the recent annual meeting: Eric Temple Bell, professor of mathematics, California Institute of Technology, Pasadena, California; Charles Peter Berkey, professor of geology, Columbia University, who has recently made investigations of the ancient rock layers of Asia; William Bowie, chief of the Division of Geodesy, U.S. Coast and Geodetic Survey, Washington, an authority on isostasy; Arthur Holly Compton, professor of physics, University of Chicago, known for his work on the Compton effect; Benjamin Minge Duggar, botanist of the Missouri Botanical Gardens, St. Louis, known for his work on plant diseases and plant physiology; Thomas Alva Edison, the distinguished inventor; Rollins Adams Emerson, professor of plant breeding, Cornell University; Herbert McLean, professor of anatomy, the University of California, the discoverer of vitamin E; William King Gregory, curator of palæontology in the American Museum of Natural History; Edwin Powell Hubble, of the Mount Wilson Observatory, California, known for his work on distant nebulae; Claude Silbert Hudson, chemist at the U.S. Bureau of Standards; Alfred Newton Richards, professor of pharmacology at the University of Pennsylvania; Francis Peyton Rous, physiologist of the Rockefeller Institute for Medical Research, New York City, who has done fundamental work on the nature of cancer; Albert Sauveur, professor of metallurgy at Harvard University; Henry Van Peters Wilson, professor of zoology at the University of North Carolina, an authority on sponges and the lower vertebrates. The following foreign associates have been elected: Paul Sabatier, professor of chemistry,

University of Toulouse, known for his work on metallic catalysts; Godfrey Harold Hardy, Savilian professor of geometry at the University of Oxford, and Carl Stumpf, emeritus professor of philosophy at the University of Berlin, originator of a new theory of sound and music.

SIR RICHARD GLAZEBROOK has been appointed, by Order of Council dated May 26, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

SIR DANIEL HALL retired on June 4 from the post of Director-General of the Intelligence Department of the Ministry of Agriculture, which he has held since 1920. Sir Daniel will continue to act as Chief Scientific Adviser and chairman of the Research Council of the Ministry.

MR. H. C. SAMPSON, who was recently appointed economic botanist at the Royal Botanic Gardens, Kew, is leaving on June 11 for British Guiana at the invitation of the Governor and under the auspices of the Colonial Office and Empire Marketing Board, to study and report on various agricultural matters in the colony. He will also visit Trinidad and the Imperial College of Tropical Agriculture, and Barbados.

THERE have already been published, through De Gruyter of Berlin, two volumes of the *Vorgeschichtliches Jahrbuch*, dealing with the literature for 1924-1925. Owing to the sudden death of the collaborator for Great Britain and Ireland, the report on the literature of prehistoric archaeology issued in those countries during 1926 has been undertaken by Dr. A. Mahr, Naturhistorisches Museum, Burggring 7, Wien 1, Austria, and to him all relevant publications should be sent, either as a gift or on loan, at the earliest date possible.

At the anniversary meeting of the Linnean Society of London, held at Burlington House on May 24, the following were elected officers of the Society for 1927-28: *President*, Sir Sidney F. Harmer; *Treasurer*, Mr. H. W. Monckton; *Zoological Secretary*, Dr. W. T. Calman; *Botanical Secretary*, Mr. J. Ramsbottom. The Linnean Gold Medal was presented to Dr. Otto Stapf in recognition of his contributions to the advancement of botanical science. The Crisp Award and Medal were given to Dr. H. Graham Cannon, professor of zoology at the University of Sheffield, for his paper "On the Post-Embryonic Development of the Fairy Shrimp," published in the Society's journal.

WE have received the fourth number of *Brighter Biochemistry*, the illustrated journal of the Biochemical Laboratory, Sir William Dunn Institute, Cambridge. It fully maintains the reputation of its predecessors in dealing with the lighter, but not always apparently the brighter, sides of this science. Opportunity is taken to publish a First Depression from the Sir William Dunn Academy, in which a now famous portrait is but faintly disguised. New features are Researchers' Fables and an account of a visit to the twelfth International Congress of Physiology at Stock-

holm. For the rest, poems—or had we better say rhymes—and short 'scientific' articles amuse the reader, and can be enjoyed by any one for the moderate price of half a crown, payable to the editors at the Sir William Dunn Institute.

THE Swiss Society of Natural Sciences is holding its annual meeting this year on Sept. 1-4 at Basel. This will be the hundred and eighth session of the Society and the seventh occasion on which it has met in Basel. The general programme includes the opening address by the president, Dr. Fritz Sarasin, on Sept. 1, followed by a lecture by Prof. A. Brachet (Brussels) on the causes and factors of morphogenesis; other lectures will be given by Prof. L. Courvoisier (Berlin) on recent work and views in astronomy, by Prof. L. Duparc (Geneva) on the Urals from the point of view of geophysics, geology, and mining, and by Prof. H. E. Sigerist (Leipzig) on Paracelsus in relation to modern thought. The general work of the meeting will be divided among fourteen sections covering various aspects of science, communications for which should be received before June 30. All correspondence regarding the meeting should be addressed to Dr. Fritz Sarasin, 22 Spitalstrasse, Bâle.

THE series of postcards issued by the British Museum (Natural History) has received an interesting and attractive addition in the form of reproductions in colour of illustrations of medieval natural history from "Hortus Sanitatis," printed by Jacob Meydenbach at Mainz in 1491. Of particular interest are the drawings of mythological animals, such as the tyras, draconopede, sea horse, maricomorion, onocenthaurus and orasius, where the artist has had to rely on his own imagination, aided by the writings of classical mythology. The illustrations of animals such as the hippopotamus, chameleon, cameloleopard and the great ant, which the artist had never seen but had drawn from some traveller's description, are extraordinarily fascinating in their quaintness. The whole series is one of remarkable interest, and it is to be hoped that further additions will speedily follow. The illustrations are very clearly and pleasingly reproduced, and well maintain the excellent standard of the coloured postcards already issued by the Museum.

THE first number of *The Countryman*, a new illustrated quarterly review and miscellany of rural life, edited and published by J. W. Robertson Scott at Idbury, Kingham, Oxford, appeared in April last. It is a periodical concerned with the welfare of the men and women who live on the land and their cultivation, and has as its object the provision of brisk, timely, and authoritative articles, together with skilful and appetising digests of that practical information in every department of rural welfare which is at present scattered in books, journals, and papers. It is non-party in character and is intended to be of equal interest to men and women, and to help stimulate their efforts in the improvement of rural conditions, whether their activities are concerned with the problems of education, housing, village clubs or women's institutes,

etc. Amongst the varied articles in the first number are the following: "Countryman Conversations," "The Trees we might have," "Is the Farmer Dead Beat?" "Aerials for Arable," "The Genteel Cottage," and "New Rural Tales," while authors include Sir Daniel Hall, Sir Francis Acland, Mr. Noel Buxton, and Sir Charles Bright. A special treatment of country books is promised for the second number.

THE third issue of the *Journal of the Royal Technical College*, Glasgow, bearing the date December 1926, is a handsome production, and affords evidence of the activity of members of the College in research. The contents range over the fields of chemistry, physics, engineering, metallurgy, and bacteriology. An important paper by A. D. Third deals with compression losses in nozzles, the method used being that of photographing through the parallel glass sides of a diverging nozzle, the faces of which have been coated with a layer of a very viscous oil, which is thinned or swept away by the jet of air. A. S. Clark describes experiments to determine the relation between rapid tensile tests of metals at high temperatures and their creep limits, whilst O. Sneed has determined the efficiency of arrangements for preheating air for furnace combustion. J. H. Andrew suggests an explanation of the fact that overheated mild steel usually appears on microscopical examination to contain more than its actual amount of carbon, and R. Hay and R. Higgins make a further contribution to the vexed question of the relations between austenite and martensite in hardened steels. The chemical papers deal with double salt formation, the induline dyestuffs, and the activity theory of solution, as well as with the preparation of a number of organic compounds. A curious photo-electric phenomenon observed by J. B. Somerville on steel surfaces suggests further investigation. There are other contributions of considerable scientific interest.

THE annual report for 1925-26 of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has recently been published. The non-magnetic ship *Carnegie* was out of commission during the year, and such ocean work as was done was due to Amundsen's ship *Maud*, which is associated with the Department in its magnetic work. Land survey work was also mainly in abeyance, though two survey parties were at work in Africa and America. The Department now maintains two magnetic observatories, in Western Australia and in Peru, and co-operates in the electric work of the Samoa Observatory. Vol. 5 of the *Researches of the Department*, dealing with the ocean work of the *Carnegie* from 1915 until 1921, was published during the year, and progress was made in the reduction of other observations made in various regions, to be published in vols. 6 and 7. The Department co-operated with the Geophysical Laboratory of the Institution in an important research upon the effect of high pressures on the magnetisability of nickel, meteoric and other kinds of iron; the high pressures are found to reduce the critical temperature, and the research seems to preclude the possibility that the

earth's magnetism is due to permanent magnetisation of the interior. The Department has co-operated in radio investigation of the high-level conducting layer of the atmosphere, and members of its staff have also made researches on problems of atomic physics.

THREE catalogues of second-hand books, maps, etc., numbered respectively 495, 496, and 497, have recently reached us from Mr. F. Edwards, 83A High Street, Marylebone, W.1. They deal with publications concerning "The West Indies," "London and its Environs," and "The Indian Empire." Copies can be had free from the publisher upon application.

MR. JAMES THIN, 54 South Bridge, Edinburgh, has just issued a very full list (No. 215) of books dealing with natural history subjects. Upwards of 2700 works are catalogued under the headings of agriculture and husbandry, bees and bee-keeping, botany, entomology, ferns, forestry, fruit culture, fungi, gardening, geology and palæontology, grasses, marine and freshwater zoology, mosses, natural history (local and general), and ornithology. The catalogue is obtainable free upon request.

THE course of lectures on "The Mind" which was delivered this year at King's College, London, by various authors, is to be published by Messrs. Longmans and Co., Ltd. The subjects and contributors are as follow: Biology, Prof. J. S. Huxley; Physiology, Prof. R. J. S. McDowall; Psychology, Dr. F. A. P. Aveling; Psychotherapy, Dr. J. A. Hadfield; Physics, Prof. F. A. Lindemann; Philosophy, Dr. W. R. Matthews; Education, Prof. J. D. Wilson; Esthetics, R. G. Collingwood; Anthropology, Prof. C. G. Seligman; and Sociology, Prof. L. T. Hobhouse.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in engineering and a lecturer in chemistry and physics at Stockport College for Further Education—The Principal (June 17). A vice-principal of the Somerset Farm Institute, Cannington—The Principal, Somerset Farm Institute, Cannington, near Bridgwater (June 20). An assistant pathological chemist at St. Mary's Hospital, Paddington—The Secretary, St. Mary's Hospital, W.2 (June 20). A part-time demonstrator in geology at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 24). A full-time lecturer in mathematics and science in the School of Science and Art, Newark—The Principal, School of Science and Art, London Road, Newark-on-Trent (June 25). A vice-principal of the Royal Agricultural College, Cirencester—Dr. J. A. Hanley, The University, Bristol (June 25). A professor of technological chemistry in the Manchester Municipal College of Technology—The Registrar, Municipal College of Technology, Manchester (June 28). An assistant professor of metallurgy at University College of Swansea—The Registrar, University College, Swansea (July 2). A biochemist and a bacteriologist at the National Institute for Research in Dairying—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading.

Research Items.

MADI RAINSTONES.—Mr. F. H. Rogers contributes to *Man* for May some valuable notes on rainstones in three areas in East Africa—Meturu, near Dufile, on the Nile, Metuli and Laropi, also near Dufile. In Meturu there are two sets of these stones; one, of four stones, is said to have been brought from the Bari country by Moyi when flying from a jealous brother—the present chief is sixth in succession from Moyi. As there was a good deal of rain when Moyi arrived, he gave out that it was on account of these stones. The second set of stones consists of ten, which have been found from time to time during the reign of the present chief. They also are much venerated. On account of their special shape and smoothness they are considered to have been moulded by God. The stones are kept in a pot and nominally are in charge of the chief, but as they may be handled safely only by boys and old men, he usually deposes some one else to guard them and carry out the rain-making ceremonies. At present the guardian is the chief's mother. If the government has found it necessary to appoint a reigning chief from another family, the custody of the stones still remains in the hereditary rain-making family. When the rains fail, a meeting is called under the *rudu* or sacred tree, a bull is killed and eaten, and a general request for the rain-making ceremony is put forward, when the custodian is instructed accordingly. The custodian then kills a black sheep and anoints a young member of the family, who is under instruction, on the forehead, chest, back of the hands, and dorsum of the feet, with fat from the kidneys. He is then sent to fetch water from the River Areze, with which the stones are carefully washed, first separately, then in the pot. They and the pot are then smeared with fat and put away after the remainder of the water has been poured on them. The boy then goes to sleep for the night, lying prone on his face to ensure an equal distribution of rain over the whole country.

THE PHYSIQUE OF FILIPINOS.—In the *Philippine Journal of Science* for March, Juan C. Nafias and Leon C. Santiago have analysed measurements of 713 university students, of whom 564 are male and 149 female. These measurements were not made by the authors themselves, and though both sets present certain deficiencies, those of the female students are in particular especially defective, and can scarcely, for the most part, be regarded as significant for the authors' purpose. The coefficient of variation in each group of measurement is such that the groups cannot be regarded as homogeneous. This is as might be expected, as the regional distribution of the students is wide and there is considerable blood intermixture, ranging from Filipinos of pure Malay type to those of near or distant Chinese and Spanish lineage, as well as hybrids of the various constituent elements of the population. The measurements here analysed are stature, weight with the derivative indication of build, and vital capacity, chest circumference, and the derivative index of constitution or robustness. The figures for the Filipinos are compared with university students of Great Britain and the United States where these are available, and the military measurements of Europeans, United States, and Mongolians—North and South China—Korea, and Japan; also Siamese civilians. In stature the Filipinos correspond with the South Chinese group, the measurements being Filipinos 163.3, South China 163.1, but in all the other measurements they show a surprising deficiency, both proportionate and absolute. The authors regard this as an indication

of serious underdevelopment and malnutrition among the students, and, as they may be regarded as a select class, of a still more serious condition among the average of the inhabitants. The figures relating to the female students, notwithstanding their defects, point even more emphatically in the same direction.

BIOLOGICAL STUDIES AT THE TORTUGAS.—An interesting summary of the work carried out at the Tortugas Laboratory during the summer of 1926 is contained in Year Book No. 25, 1925-26, of the Carnegie Institution of Washington. Investigations were conducted by eleven workers, Dr. W. H. Longley acting as administrative officer for the season. Floristic studies, both on algæ and diatoms, were carried out, and the fauna, especially in the case of fish and amphipods, was further investigated. Dr. Paul Bartsch continued breeding experiments on cerions, while a series of interesting experimental studies were carried out by other workers. These included experiments on the electrical conductivity in the alga, *Valonia*; on the behaviour of trematode larvæ; on the organisation of echinoderm eggs; and on regeneration in the starfish, *Linckia*. Working with the micro-manipulation apparatus designed by himself, Dr. C. V. Taylor, together with D. H. Tennent and D. M. Whitaker, found, as a result of work on the eggs of *Lytechinus variegatus*, that, in opposition to Boveri's classic observations, there is no localisation of micromere-forming material nor any evidence that this substance has been differentiated before fertilisation. They found evidence, however, of the differentiation of ectoderm-forming substance over the entire surface of the egg even before fertilisation, the endoderm substance being excluded from the superficial layers of the egg. J. M. Valentine's work on regeneration in *Linckia* revealed a number of interesting points, notably that, though autotomised arms in this genus can regenerate an entire animal, this did not occur after isolated arms had been cut off, also that the latent period before the beginning of regeneration, where an arm only was concerned, was about a third of that necessary when a part of the disc was involved. Where arms were amputated at various levels the buds which developed nearest the disc grew most quickly.

A PARASITE OF THE GREENHOUSE WHITE-FLY.—In the *Bulletin of Entomological Research*, vol. 17, Part 3, March 1927, Mr. E. R. Spoyer, of the Cheshunt Research Station, gives an account of the life-history of a small chalcid, *Encarsia formosa*, which parasitises the common greenhouse white-fly. It appears that an individual female *Encarsia* may lay its eggs in the pupæ of fifty or more of its host. The parasitic larvæ that emerge from these eggs destroy the white-fly pupæ: the skins of the latter become black, and this feature distinguishes the parasitised pupæ from normal white scales and pupæ. The parasite thrives best at high temperatures and is probably a tropical insect possibly imported into Great Britain from India. It is noteworthy that fumigation with hydrocyanic acid gas as practised commercially for the control of the white-fly is stated to leave the parasites unaffected. Whether this insect can be utilised as an auxiliary method of controlling the white-fly it would be premature to decide, as the author mentions, for example, that it is uncertain how it passes the winter, if indeed it is able to do so in Great Britain, without artificial heat. The species is parthenogenetic, males are scarce, and have so far only been found under conditions that were

preceded by low temperatures in September and October. In a glasshouse that was specially heated over the same periods, no males could be found. It appears probable, as in some other chalcids, that males play an insignificant rôle in the economy of the species and that habitual parthenogenesis prevails. This latter feature is an advantage from the economic point of view, in that pairing has not been arranged for and the insect evidently reproduces freely and would require comparatively little attention.

THE COTTON PLANT.—M. A. Bailey and T. Trought, of the Egyptian Ministry of Agriculture, working along the analytical lines first introduced by Dr. W. Lawrence Balls, have made some considerable contribution to our knowledge of the development of the cotton plant (Technical and Scientific Series Bulletin, No. 60, Ministry of Agriculture of Egypt). They adduce evidence to show that the normal period of development of a flower bud of cotton in Egypt is not less than 42 days, and the period required for boll development about 52 days. The development of the sympodial flowering branch is traced from an early stage, and it is shown that the four succeeding internodes are laid down before the first internode has reached its final length. The existence of regular flowering intervals in Egyptian cotton plants is demonstrated, and the intervals are shown to be of a similar order to those found by Harlan in the case of Sea Island cotton. Balls has directed attention to the fact that the daily flowering curves for a group of plants exhibit marked fluctuations from day to day, and further, that the curves for two different crops of cotton grown apart often exhibit a marked concordance in their fluctuations, to explain which he suggests some fluctuating environmental factor with a wide range of influence, e.g. day and night temperatures obtaining at commencement of flower-bud development. The present authors are unable to confirm this suggestion, and data are given to show that the minimum temperatures which occur when the bud primordia are being differentiated have no effect on the length of the interval between the flowers which open about 42 days later. They conclude from their evidence that flower-bud shedding is not only the principal factor affecting the fluctuations of average flowering curves, but also one of the most important factors affecting the yield of cotton in Egypt at the present time. A further paper on the nature and effect of bud shedding is promised.

CHROMOSOMES OF PIGEONS.—A study of the chromosomes of the pigeon, by Mr. Kan Oguma (*Jour. Coll. Agric. Hokkaido Imp. Univ.*, Sapporo, Japan, vol. 16, part 6), yields some interesting results. In counting the chromosomes from seven embryos belonging to four clutches of eggs, four embryos had 61 chromosomes and three 62, including in each case six very minute pairs. The unpaired or X-chromosome is a large one. In the spermatogonia of adult males, 62 chromosomes were counted, including two (XX) of the maximum size. These numbers are much higher than those found in early studies of the pigeon, in which the chromosomes were lumped through insufficient fixation. Also there is no evidence of a double reduction division, as reported by Guyer. These chromosome conditions indicate that the female is the heterozygous sex, which is in harmony with the genetic evidence for birds. It has long been held that each clutch of eggs in the pigeon produces one male and one female, but in 50 clutches examined both eggs were of the same sex as often as they were of different sexes. Contrary to the description of the chromosomes of fowls by Hance, no fragmentation of chromosomes

is found in the pigeon. Similarities between the chromosome groups of birds and reptiles (lizards) have been pointed out, each having both macro- and micro-chromosomes; but birds have also some chromosomes of intermediate size.

SUGAR BEET.—The fourth Rothamsted Conference (London: Ernest Benn, Ltd., 1927) deals with the culture and manuring of sugar beet. Some account of continental practice is given, which though of great value to the English farmer, must be thoroughly tested under local conditions before it can be used to full advantage. The yield of beets in England is at present unsatisfactory though the quality is good, but under existing terms of contract the total yield is of greater importance provided both conditions cannot be realised simultaneously. The methods of cultivation of the crop require much further experimental work. The question of manurial treatment is less urgent, though the latter has yet to be correlated with the varied conditions of soil and climate in Britain. The suitability of climatic conditions for growing sugar beet in England seems indisputable, and points to the possibility of success for the industry.

WOOD PULP FROM POPLAR.—Science Service has issued an illustrated popular account of recent experiments in crossing poplar trees to produce a rapidly growing hybrid tree for the production of wood pulp. Poplar gives a higher quality of paper than spruce, and the rapid depletion of forests for the production of wood pulp has led to this attempt to regenerate forests at a more rapid rate. Hybrid vigour is a well-known fact, observed by Darwin. Although the cause remains somewhat obscure, certain hybrid walnuts have long been known to grow at a rapid rate, and the best of these hybrid poplars are said to be capable of growing to a diameter of 18 inches in 18 years and yielding 100 cords of wood to the acre. There will be plenty of need for them, as the United States consumed a total of 5,565,831 tons of wood pulp in 1925. Once produced, the hybrids can readily be multiplied by cuttings, since they root as readily as willows. This is probably the first attempt to increase wood production by breeding methods, and it may lead to large results.

NEW SPECIES OF MOLLUSCA IN THE UNITED STATES NATIONAL MUSEUM.—The veteran Dr. Dall (now, alas, deceased), in continuation of similar work on the same lines, publishes some diagnoses of undescribed new species of mollusca in the collection of the United States National Museum. The shells dealt with belong to the Scaphopoda, Gastropoda, and Polyplacophora. Unfortunately the descriptions are not accompanied by figures, which would have added to the value of the paper.

EARTHQUAKES AND THE TILTING OF THE GROUND.—For some years before the Japanese earthquake of 1923, mareograph records revealed a continuous depression of the coast of Sagami Bay. This was succeeded by a period of repose, and then came the great earthquake and with it a marked elevation of the coast (NATURE, vol. 119, p. 254). Led by these observations, Mr. M. Ishimoto erected a pair of horizontal pendulums of the Zollner type in a cellar of the Imperial University of Tokyo in order to determine if any tilting occurred before or after earthquakes. He has recently published a preliminary paper on the observations made last summer (*Bulletin of the Earthquake Research Institute*, Tokyo, vol. 2, 1927, pp. 1-12). The principal change of inclination

is diurnal, and closely follows the change of air-temperature. When distant earthquakes occur, the instrument shows no change of inclination. But after some near earthquakes the record shows a slight change, either of elevation or depression, in the direction of the epicentres. One observation may prove of considerable interest. On Aug. 3 a strong earthquake occurred with its epicentre in Tokyo Bay and 33 miles south of Tokyo. Two weeks before, there was an anomaly in the N.-S. component independent of the diurnal variation. Just before the earthquake, the pendulum indicated no change. After it, the record was lost owing to the fracture of the suspending quartz-fibres.

INTERFERENCE OF RADIO-WAVES.—In the *Zeitschrift für Hochfrequenztechnik* of December last, E. Quäck discusses the interference which is produced when using high-frequency radio-waves, by the waves which have travelled one way round the earth with those that have travelled the other way. In the short-wave radio messages sent last October between America and Berlin, the signals recorded on the tape were often mutilated in such a way as to suggest an interference of this kind. The Telefunken Company investigated the phenomena and proved conclusively that the waves did travel round the world in opposite directions. Assuming that the velocity of the waves is the same as that of light— 3×10^{10} cm. per second—the difference between the lengths of the paths of the two waves comes out to about 28,800 kilometres, the time lag being 0.096 of a second. In another experiment a signal transmitted from Nauen on a wave-length of 15 metres was received at the neighbouring town of Geltow. The first signal came directly over a few kilometres; the second was given by the waves which had travelled round the world. The time lag between them showed that if the waves had travelled with the velocity of light at a height of 182 kilometres above the earth's surface, the time difference between the arrivals of the signal would have been the same. It is curious that this so-called 'echo' effect has only been observed when using wave-lengths lying between 15 metres and 22 metres. Further investigation of this phenomenon may throw light on the method of the propagation of the waves through the upper atmosphere.

PIEZO-ELECTRICITY OF QUARTZ.—A new investigation by L. H. Dawson of the piezo-electric properties of crystalline quartz has brought to light a number of fresh facts (*Physical Review*, 29, p. 532; 1927). When a paralleloiped cut with an electric axis normal to a large face was explored, it was found that the local charges developed varied from point to point both in magnitude and sign, but the irregularities were of a permanent nature, surviving, for example, temporary transition to the β modification. The accepted Curie constant is only an average value when large areas are employed. The curved surface of a cylinder the end of which was parallel to the plane of the electric axes showed three positive areas and three negative areas, spaced symmetrically, providing a way of finding the electric axes when only the optic axis was known. When the temperature was varied, the piezo-electric effect passed through a maximum at 60° C., and the cooling curves showed a lag. All the crystals were cut under exceptionally good conditions, and appeared free from flaws when examined optically. The results seem to be consistent with the idea that large crystals are not perfectly formed, for which there is independent evidence from X-ray analysis, but the author considers that it will be difficult to account for them completely with the

present knowledge of the molecular structure of quartz.

COMPUTING MACHINES.—Computing machines of various kinds have become part of the normal equipment of most scientific departments and large business firms. It is of especial interest, therefore, to examine the relative merits of these machines. In a lecture delivered under the auspices of the Office Machinery Users' Association on Feb. 15, Dr. L. J. Comrie performs this useful function. According to him the ideal machine should perform all the operations with equal facility (adding or listing machines merely, are deficient in this respect), and the result should be visible immediately on completion of the operation. The keyboard should be uniform to touch for all numbers, and should not allow two keys to lock simultaneously. Moreover, it should not be necessary to reverse a special lever for subtraction, or, as in the case of most arithmometers, should the carriage require to be lifted at any stage; there should be tens transmission throughout the multiplier and product registers, and it should have a sight dial. A number of other important points are dealt with and the various machines are classified according to whether or not they possess these characteristics. In the case of the hand-operated barrel-type machine, Dr. Comrie holds that the Nova Brunsviga stands out above the others, but with the electrically operated machine the case is not so clear. Dr. Comrie evidently in his merit classification has in mind the use of such a machine in a department where every second saved in the computation is of importance. While this is so in large insurance offices, and even in statistical and mathematical laboratories, the ordinary scientific worker is not so pressed usually that he requires to consider a minute or so gained on a long calculation. Where the machine is to undergo strenuous operation of the type contemplated, the life of the machine, wear and tear and elastic fatigue become important considerations. These factors do not appear to have been dealt with by the lecturer.

FLAME MOVEMENT.—Among the large amount of work carried out by the Safety in Mines Research Board, one of the most important subjects is the study of the propagation of flame in closed vessels. Paper No. 32, published by H.M. Stationery Office (1s. net), by O. C. de C. Ellis, contains a summary of the principal methods used in the study of flame movement. Although the earlier methods enabled the speed of the flame to be measured, it was not until the method of snapshot photography had been devised that a close determination of the mode of propagation could be made. This method is fully described in the paper, and is illustrated by means of a number of excellent plates.

ANALYSIS OF COAL.—We have received a copy of the report on the methods of analysis of coal which has been prepared by the Fuel Research Division of the Department of Scientific and Industrial Research. The methods which this report (London: H.M. Stationery Office, 1927. 9d. net) describes have been adopted by the Research Department for the purpose of its work on coal, and it is hoped that they will be adopted generally by analysts throughout Great Britain so that all results of coal research may be strictly comparable. The paper contains detailed information with regard to the analysis, and the determination of the caking index and the calorific value of a given sample of coal. Two methods of carbonisation assay are described, and an example illustrating the form in which an analysis should be reported is included.

The New Science School at Clifton College.

IN the development of the teaching of natural science in schools, Clifton College has, from the earliest days, played a very important part. Fortunate in possessing a succession of sympathetic headmasters, and in securing the services of men like Debus, Worthington, Sir William Tilden, Shenstone, and Rintoul, Clifton rapidly acquired a reputation for sound scientific education, and exerted a powerful influence upon contemporary educational practice. Laboratories were built and well equipped, and there was a constant stream of visitors to see what were then the latest developments of the new movement.

genre is well known to scientific workers. The total cost of the scheme is estimated at £50,000; and Mr. Whatley was able to announce at the opening of the building by the Prince of Wales on June 2 that four-fifths of this amount, or £40,000, had already been given. This satisfactory result is due almost entirely to the unaided efforts of the Right Hon. J. H. Whitley, Speaker of the House of Commons, who has interested himself personally in the scheme from the outset.

The new buildings are the outcome of a number of alternative designs. The preservation of the Close

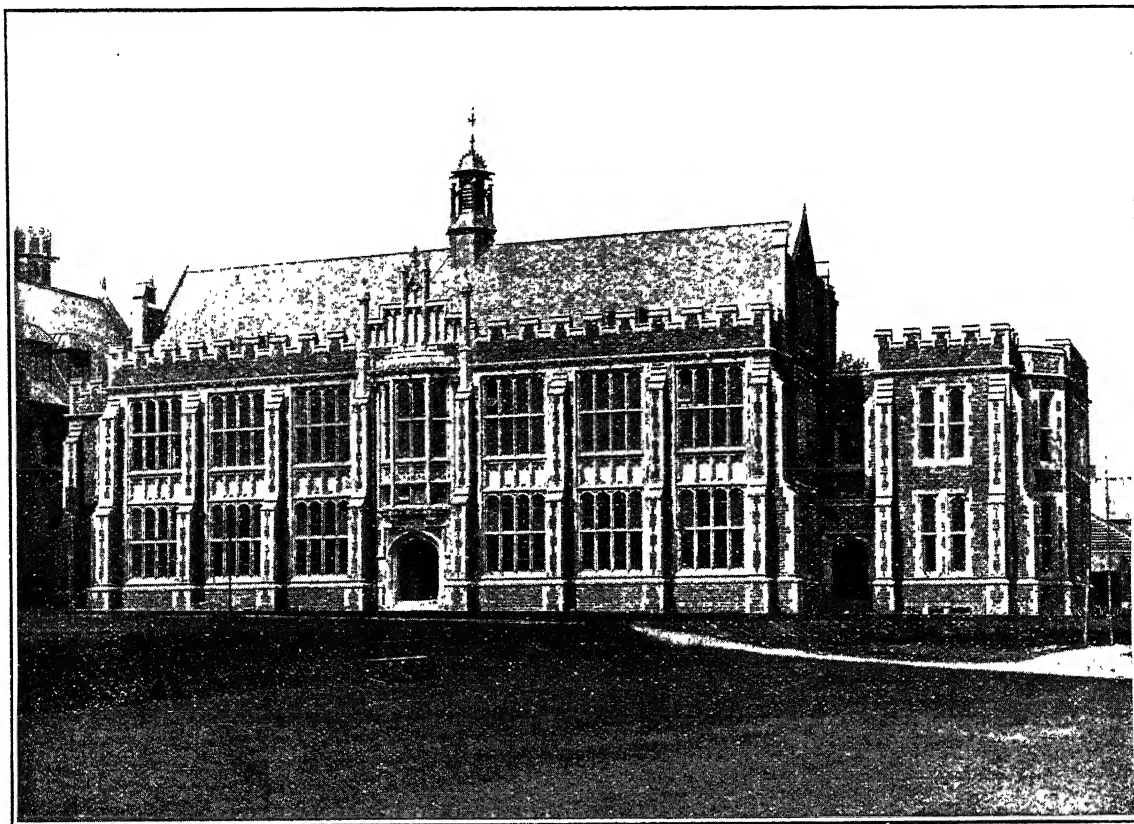


FIG. 1.—The new Science School, Clifton College.

At this time the College far out-distanced other schools in accommodation for science teaching, but, like many other pioneers, it has since been left behind by those to whom it pointed the way. Some expansions and improvements were made from time to time, but finally the buildings became so much out-of-date and inadequate to the needs of the school that new and extensive premises were a necessity. When, thanks to the initiative of Mr. Norman Whatley, the present headmaster, the problem was at length seriously taken in hand, it was resolved to erect an entirely new science block, worthy of the tradition of the school, and one, too, which should restore to Clifton its former position in the van. Old Cliftonians responded generously to the call for funds, and sufficient was soon forthcoming to allow the council to proceed with the scheme. A stroke of good fortune came at once, in that it proved possible to secure the services as architect of Mr. Alan E. Munby, whose genius in this particular

for games was regarded as all-important, and this accounts for the somewhat recessed position of the buildings, which cover a considerable ground area. The frontage to the Close is shown in Fig. 1. Few modern science buildings are erected in the Gothic style, but in this instance it was felt that the architectural surroundings of the College left no possible alternative, and by the adoption of a late period in this style, the difficulty of securing the ample natural light necessary has been met satisfactorily. Bath-stone has been employed, with local stone for general walling, as used in other college buildings.

The design comprises two principal floors with a partial basement and partial second storey. The extreme length of the building is some 160 ft. and the breadth about 64 ft. As shown on the plan (Fig. 2), there is a central block, which contains the laboratories and their adjuncts, with two wings of two storeys only, devoted to four lecture-rooms. This plan illustrates the first (chemistry) floor, as

presenting more technical details than the ground floor, the plan of which is similar.

PHYSICS.

The old accommodation consists of one laboratory and two lecture-rooms. The latter will just suffice—with difficulty—for the theoretical classes, but the laboratory and storage places are greatly overcrowded. Classes much too large, for the laboratory follow one another continuously, so that the distribution and collection of apparatus seriously curtail the short time available for work, and no experiment can be left set up to be finished later. The school is well equipped with apparatus for this single physical laboratory, but lack of space and the vibration of the floor render the use of the more delicate instruments practically impossible. In the new Science School the ground floor is devoted to physics, and comprises two elementary laboratories on the frontage, 40 ft. by 32 ft., on either side of the central entrance. The latter gives access to a corridor, at the ends of

the water, gas, and electric current are brought to convenient points on the walls. The adjoining store-room can be darkened for use as an optical room. All the working rooms are provided with gas, water, and steam supplies, and, as is necessary in the teaching of modern physics, liberal electrical supplies, including main and low-voltage alternating current, and direct current distributed from a battery in the basement by a switchboard specially designed to give to each room separately a full range of voltages with equal distribution of loads among the cells of the battery. All pipes and other bench fittings are non-magnetic. Firm supports to carry heavy mechanical apparatus have been built into the walls and ceilings at convenient places. The flooring of the whole of the physics section is of maple blocks on concrete, to ensure complete absence of vibration.

CHEMISTRY.

The first floor (illustrated in Fig. 2) is devoted mainly to chemistry, but there is also a biological

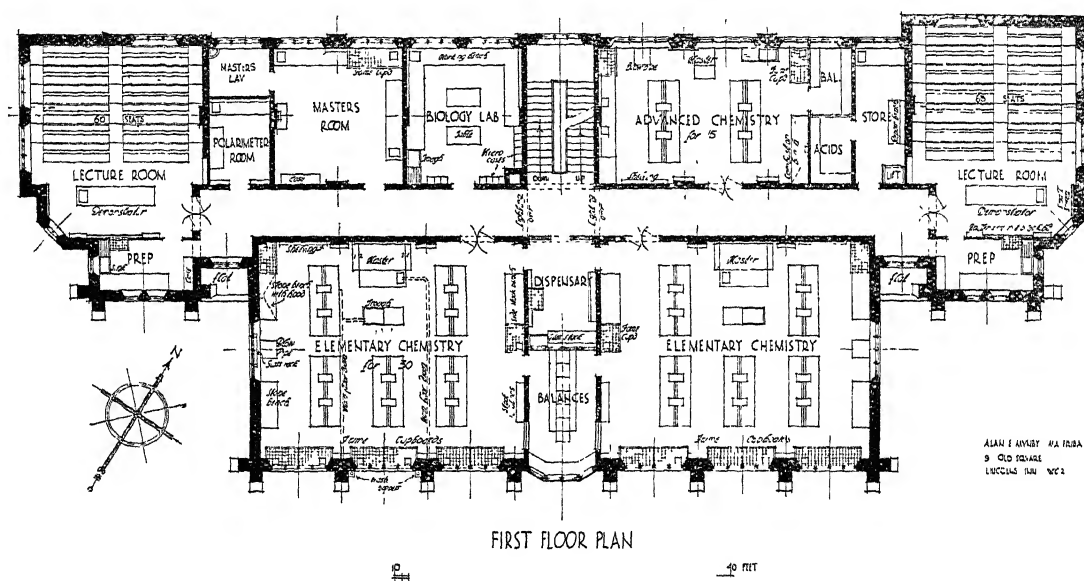


FIG. 2.—Plan of first floor of new Science School, Clifton College.

which are the two lecture-rooms with preparation rooms attached. Separate external approach to the preparation rooms is given by doors to the corridor terminations. On the other side of the corridor are, on the right, an advanced laboratory, 37 ft. by 20 ft., with adjoining store, and on the left of the central staircase a repair workshop 17 ft. by 20 ft., and a master's room 19 ft. by 20 ft. A research room and a photographic dark-room are also provided on this floor.

The two elementary laboratories are well lighted, and are spaced to give accommodation for classes of 30-36; they are large enough to store the necessary apparatus so that it is properly protected and easy to distribute. The apparatus drawers are uniform in size with those of the main physical store-room, so that a complete change of apparatus for each term's work may be effected with the minimum trouble and in a very short time. The benches are fixed, as the rooms will be used for large classes for short periods.

The laboratory for advanced work has been carefully designed to meet the requirements of higher certificate and university scholarship candidates. It has movable tables, to render it more elastic, and

laboratory designed to accommodate 15 to 20 boys. In the general arrangement of the lecture-rooms advanced laboratory and elementary laboratories, this floor resembles the one below. The space occupied on the ground floor by the entrance hall is, however, usefully employed on the chemistry floor in providing a balance room and dispensary, common to both elementary laboratories. The dispensary, in which laboratory assistants are constantly on duty, serves as a distribution room and store for common apparatus.

The lecture-rooms will each hold sixty boys with ease and comfort; the average sets are of course only about half this size, but a large lecture-room enables two sets to be taken together upon special occasions such as lantern lectures or particular topics, and will also accommodate sectional meetings of the scientific society. Large lecture-rooms are also much pleasanter, in that the atmosphere of a small room, however efficiently ventilated, may become distinctly unfitted for boys during lectures on chlorine, phosphine, etc. In planning school laboratories and science rooms, too little consideration is often given to the fact that young people

are in general much more sensitive to fumes, poisonous gases, and other similar effluvia, than are many adults.

This important point has been borne in mind in the design of the elementary laboratories, where sufficient fume-cupboards have been erected (mainly along the windows) to provide for the whole class when working upon unpleasant substances. The cupboards are themselves efficiently ventilated, so that it is hoped that the air of the laboratories may remain fresh even in the most adverse circumstances.

In the balance-room the balances are enclosed in special cases built as part of the fittings. They are placed on stable benches, which are wide enough to take open exercise books immediately in front of the balances.

The advanced laboratory will provide good working accommodation for twenty boys. A stone slab, covered by an asbestos hood, will be used for combustions and similar work, while a Carius cupboard, fitted with concrete floor, tiled sides, sliding steel door and an interior light, is built under one of the fume-cupboards. A separate balance-room is attached to the laboratory. Steam, gas, electricity, and water are laid on to this as to all other working rooms. One feature worthy of special note is that all filter-pumps are worked, not from the general laboratory circuit, but from a separate main communicating with the town main in the adjoining road.

BIOLOGY.

At present, biology is taught mainly in the junior school and the lower forms of the senior school; the biological laboratory in the new building is a small room (to hold eighteen or so) for the accommodation of the class of First M.B. candidates. Should further space be required for biology in the future, a large room on the second floor, to be used temporarily for physical geography, has been built in such a way that its conversion to a biological laboratory could be carried out with very little difficulty or expense.

The chemistry floor includes, in addition to the rooms already mentioned, a polarimeter room and a room—partly office, partly private laboratory—for the head of the science department. By reducing the corridor height on this floor some cross lighting and ventilation has been made possible.

THE SCIENCE LIBRARY.

The most attractive room in the building is the library, on the second floor. A large and airy room, it is floored and fitted throughout in oak. It may, perhaps, be claimed without exaggeration that the emphasis now laid in schools upon the humanistic aspect of science has been largely due to Clifton influence; and it is therefore not surprising to find that the science library at the College includes a rich selection of classical scientific books and memoirs, which will at length find a home worthy of them.

The Royal Observatory, Greenwich.

ANNUAL VISITATION.

THE annual visitation of the Royal Observatory took place on the afternoon of Friday, June 3; the usual Saturday date being changed owing to the Whitsun holiday.

The Astronomer Royal presented his report, which deals with the work of the observatory for the year ended May 10, 1927. The usual observations of the sun, moon, planets, and fundamental stars are being continued with the Transit Circle; also of stars brighter than mag. 8.0 between N. Decl. 32° and 64°, and the stars selected for comparison with Eros at the opposition of 1931. The corrections to Brown's Tables of the moon in 1926 were +6.5" in longitude, and -0.8" in latitude; they have been slowly diminishing since the Tables were first used, in 1923. Mr. Cullen has made a redetermination of the declinations and proper motions of the brighter stars, from observations made with the instrument during the whole interval since its erection in 1850. He finds for the correction to Boss +0.33" +0.0068" ($t - 1925.0$).

The Altazimuth has also been used in recent years to find the correction to Boss's declinations from observations in the Prime Vertical; the values found are +0.29", +0.44", +0.45", +0.51" at declinations 45°, 35°, 25°, 15° respectively. These are intermediate between the values given by Raymond and Eichelberger.

The Cookson Floating Telescope has been borrowed from the Observatory of Cambridge for a third period of seven years; it is used for determining latitude variation and the constant of aberration. The reductions for the second seven years are nearly completed.

Fourteen completed determinations of stellar parallax have been made during the year with the 26-inch refractor, bringing the total up to 330.

The 30-inch reflector has been used for a determination of the effective temperatures of stars of early type; the results for twenty-two stars have recently been published in the *Mon. Not. R.A.S.* The instru-

ment has also been used by Mr. Merton for photographing comets Comas Sola, Stearns, Pons-Winnecke, and Grigg-Skjellerup.

Plates are being taken with the Astrographic Equatorial for determining proper motions by comparison with those taken twenty-five to thirty years ago. The work is now nearly complete from declination 65° to 71°. Dr. H. Groot is also examining the astrographic plates for detecting double stars on them. He has found 187 pairs with separation less than 5 seconds in the zones 65° to 71°. Mr. Merton mounted two aeroplane lenses of 20 inches focus, working at F/5.6 on the tube of the astrographic telescope. These have proved very useful for photographing comets; it was with a similar lens that Mr. F. J. Hargreaves photographed comet Grigg-Skjellerup in advance of Harvard and Yerkes Observatories.

The sun was photographed on 251 days; most of the missing days are filled by photographs taken at the Cape or Kodaikanal; solar activity has been considerable, but with marked depressions at times. Between May and January there were ten naked-eye groups; but since January there have been no very large spots. Messrs. Ross have supplied new enlarging lenses for both the photoheliographs, which improve the definition at the sun's limb.

The late Mr. W. H. Wesley made drawings of the corona from the Greenwich expeditions' photographs of 1898, 1900, 1901, 1905; also from Mr. McClean's of 1908. Miss A. M. D. Crommelin made similar drawings of the eclipses of 1914, 1919. These have been reproduced in the *Philosophical Transactions*, Series A, vol. 22. Mr. Davidson and Col. Stratton have discussed the photographs obtained in Sumatra in 1926. The results will shortly appear in the *R.A.S. Memoirs*.

A party from the observatory will visit Giggleswick for the eclipse of June 29. The programme includes comparison of the intensities of certain calcium lines,

the spectrum of the chromosphere from *D* to the extreme red, and direct photography of the corona. Mr. Greaves and Mr. Witchell are viewing the eclipse from an aeroplane.

The magnetic observations are now all made at Abinger; the mean values of the elements for 1926 are: Decl. W. $13^{\circ} 10' 4''$; Hor. Force, 0.18581; Vert. Force, 0.42947; Dip, $66^{\circ} 36' 2''$. Comparison of magnetic disturbances as recorded at Greenwich and Abinger shows that the latter are smaller by about 3 per cent. The quinquennial revision of the Admiralty magnetic charts was carried out, and isogonals for 1927.5 adopted. After some necessary improvements in the insulation, the Schuster-Smith coil magnetometer was adopted as the standard from February last. A redetermination of the moment of inertia of Dr. W. Watson's standard cylinder gave a result identical with his value found in 1903; this cylinder is now adopted as a standard.

The following weather statistics are for the year ended on April 30. The average is that of the seventy-five years 1841-1915: Temperature 50.2° , being 0.6° above the average. Mean daily movement of the air, 284 miles, just the average value. Bright sunshine, 1320 hours, being 29.7 per cent. of possible amount. Rainfall, 28.20 inches, being 3.96 above

average. The wettest month was November, 4.77 inches; the driest December, 0.38 inches.

Two standard sidereal clocks (Shortt Nos. 3 and 11) have been in use since July; during the last fifty days their rates have been nearly coincident, and the clocks have never differed by more than 0.05^s . A mean time clock of the Shortt type has been ordered, which will be used for the distribution of radio time-signals through the Rugby Station. Rhythmic signals will be sent at 10^h and 18^h .

The observatory took part in the radio longitude campaign last autumn. Advance copies of the time-determinations and the times of receipt of radio signals have been printed and circulated. The corrections to the adopted longitudes of Paris and Washington appear to be less than 0.02^s . The longitude of Pulkovo was determined by the Russian observers as $2^h 1^m 18.572^s$.

Allusion is made in the report to Mr. G. Merton's researches on the comet Grigg-Skjellerup, published as an *R.A.S. Memoir*. The observed perihelion passage was earlier than the predicted time by 0.2 days.

Dr. A. C. D. Crommelin retired from the Observatory on May 10, after thirty-six years' service (see *NATURE*, May 28, p. 790).

South-Eastern Union of Scientific Societies.

ANNUAL CONGRESS.

THE thirty-second annual congress of the South-Eastern Union was held at St. Leonards-on-Sea on June 25-28, the president being Dr. A. B. Rendle, whose address was devoted to "The Flora of Sussex, Past and Present." The Wealden flora dates from the fourth continental period. Tree-ferns and other ferns comprise twenty-three out of the seventy species of Wealden plants known, a flora representing a moist, warm, and possibly tropical climate. In a paper by Dr. E. J. Salisbury it was shown that the plants that had become extinct in certain countries or had definitely diminished numbered 294, or about thirty per cent. of the total British flora, although speaking for the whole country those that had become actually extinct was surprisingly small. About eighteen or twenty seaside plants were disappearing, principally by indiscriminate picking of the flowers. Seakale was believed to have been first offered for sale at Covent Garden in 1875, and this came from Pevensy. Members were surprised at the quantity seen in flower on the beaches east of Hastings. The Mayor of Hastings, an enthusiastic botanist, read a paper of much interest on the "Weeds of a St. Leonards Garden."

In the Zoological Section Prof. E. W. MacBride gave an address on "The Origin and Nature of Mutations," a subject he has made peculiarly his own. He defined mutations as conspicuous deviations from type which occurred suddenly without obvious cause and were strongly inherited, most of them, however, being failures from the point of view of natural selection. Reference was made to Tornier's theory that abnormal variations are due to the environment in which the eggs were laid and fertilised. The effects of the weakening of the germ could be recognised in the characters of domestic breeds of wild animals. Evil conditions surrounding the egg rapidly produced mutations, and quickly as they come they as quickly go.

In a paper entitled "Territory in Bird-Life," Prof. C. Lloyd Morgan dealt with the habit of birds to separate from the flock in early spring to enter upon their territory period. Dealing particularly with the

lapwings, he said that so long as the birds were in flocks the behaviour of all the male birds was much the same, and no marked hostility was shown, but directly they got into the territory phase hostilities broke out. If a cold snap came after a warm period, the males resorted to the flock-phase and all became perfectly friendly once more. When once a male had fixed his territory he sang his best to attract the females to his area, but the males were warned off, and their presence in his territory was resented. The female that joined him was just as jealous as he was. How the territory was defined is a subject for further examination, but evidently it was a directive factor of some sort.

In the Geological Section, Mr. H. B. Milner chose for his address "The Weald-Boulonnais Section of the English Channel," and with the assistance of carefully prepared plans showed the structure of the submarine ridges in the Channel area. With the help obtained from Admiralty charts he was able to show that the gravel and other banks arranged themselves in a remarkable manner on the lines of the Armorican foldings which are so well shown in the structure of the chalk downs and the Wealden rocks. It was also seen from the charts that near the French coast there was a remarkable gorge stretching away from near Cape Blanc Nez to the North Sea, which was clearly an old drainage line, and may have some connexion with the river system which existed before the Dover Strait was pierced. There is an important bank off Dungeness, called by the French "Roc d'Angleterre", and it may be that here is an uprise of the Wealden rocks which underlie the Ness. A paper by Dr. W. M. Whittard was read on "Fossil Vertebrates from the Weald."

A large party of geologists visited Mr. Lewis Abbott's collection at 8 Grand Parade, attracted thither by the discoveries made by Mr. Abbott when the ground was excavated for the building of the White Rock Pavilion. White Rock proves to be a white chalky marl comparable to the Chalky Boulder Clay of elsewhere, containing many foreign boulders, and evidencing widespread glacial action. A large

'hand-axe' was found in the marl, and the implement was striated on its worked faces. In the upper layers of the section were found the remains of kitchen-middens, these being of later date than the glacial marl. The marl had been visited by officers of the Geological Survey, and they had accepted the glacial interpretation of the marl. In the construction of the new road here the Wadhurst Clay had been laid bare, and a whorl of a giant gasteropod was shown which had been obtained thence. The mollusc must have been several feet long. Several of the best specimens obtained by Mr. Abbott have been required for the Geological Museum. The glaciation of the south of England must now be an accepted fact.

A public evening lantern lecture was given by Mr. Edward A. Martin on "Some Amenities of the South Downs" at the White Rock Pavilion, where there was a large attendance. A fascinating cinema natural history lecture was given by Dr. Clarence Tierney to a large audience of children, and Mr. E. J. Bedford addressed another juvenile audience on "Wild Flowers."

The Union was stated to comprise seventy-eight societies, almost all of whom sent delegates to the Congress, and in addition there were many individual members of these societies present, whilst the Congress was also supported by a large number of the townspeople, and the Hastings and St. Leonards Natural History Society, at whose invitation the Congress was held there. At the Representatives' Meeting (the parliament of the Union) an invitation was brought from Rochester to hold next year's Congress at that city, when the local natural history society will celebrate its jubilee. The honorary secretary announced that Sir Martin Conway had accepted the post of president for 1928.

University and Educational Intelligence.

BIRMINGHAM.—The chair of physiology, which will be vacated by the retirement of Prof. E. Wace Carlier at the end of the present session, is to be filled by the appointment of Dr. I. de Burgh Daly, lecturer in experimental physiology in the Welsh National School of Medicine, University of Wales, Cardiff.

The following are to be among the recipients of the honorary degree of LL.D. on July 2: Sir Arthur Schuster, honorary professor of physics in the University of Manchester; Dr. A. C. Seward, Downing professor of botany in the University of Cambridge; Prof. Arthur Lapworth, professor of chemistry, University of Manchester; Sir David Ferrier, emeritus professor of neuropathology, King's College, London; Sir Watson Cheyne, Bart., and Sir Walter Fletcher, Secretary of the Medical Research Council.

CAMBRIDGE.—The Rev. G. A. Weekes, Master of Sidney Sussex College, has been re-elected Vice-Chancellor for the ensuing academic year. Major P. A. MacMahon has been appointed Rouse Ball Lecturer, and will lecture on June 7 on "The Present Stage of Knowledge of the Theory of Determinants."

Mr. L. A. Pars, Jesus College, and Mr. H. A. Newman, St. John's College, have been elected university lecturers in mathematics.

Dr. Ernest Brown has been appointed to represent the University at the centenary of the University of Toronto.

EDINBURGH.—The Senatus Academicus has agreed to offer the Degree of Doctor of Laws to the following, for conferment at the Special Graduation Ceremonial on July 20, on the occasion of the visit to Edinburgh

of the British Medical Association: Lord Dawson of Penn, Physician in Ordinary to His Majesty the King; Dr. A. Donald (Manchester); Dr. C. E. Douglas (Cupar); Sir William Hale-White (London); Mr. R. G. Hogarth (Nottingham); Dr. W. Hunter (London); Dr. T. H. Milroy (Belfast); Sir Berkeley Moynihan, Bart. (Leeds); Sir J. H. Parsons (London); Sir Humphry Rolleston, Bart. (Cambridge); Dr. G. F. Still (London); Mr. W. Trotter (London); Sir Almroth Wright (London); Prof. Vittorio Ascoli, professor of clinical medicine, Rome; M. Jules Bordet, director of the Pasteur Institute, Brussels; Prof. Harvey Cushing, professor of surgery, Harvard University; Prof. C. L. Dana, professor of nervous diseases, Cornell University; Prof. Knud Faber, professor of medicine, University of Copenhagen; Prof. Jan van der Hoeve, professor of ophthalmology, University of Leyden; Prof. Otto Meyerhoff, professor of physiology, University of Berlin; Prof. Otto Naegeli, professor of medicine, University of Zurich; Prof. W. S. Thayer, professor emeritus of medicine, Johns Hopkins University; M. T. M. Tuffier, Academy of Medicine, Paris.

OXFORD.—It is proposed to confer the honorary degree of D.Sc. upon Sir Robert Hadfield, Bart., and Dr. Richard Willstätter, professor of chemistry in the University of Munich, on Thursday, June 30; and the honorary degree of D.D. upon the Very Rev. W. R. Inge, Dean of St. Paul's, on the following day.

Sir William Dunn's Trustees have offered to provide a sum of £2000 for the endowment of a Departmental Library at their recently opened School of Pathology. A decree of acceptance and thanks will be promulgated on June 7.

The Royal College of Surgeons of England announces that the subject for the Jacksonian Prize for 1927 is "The Pathology, Diagnosis, and Treatment of Bronchiectasis and Abscess of the Lung," and that competing essays must reach the secretary not later than Dec. 31. The subject for the Jacksonian Prize of 1928 is "The Surgical Treatment of Pulmonary Tuberculosis."

The subject of the Unity History School to be held this year at Woodbrooke College on July 29–Aug. 6 is "Unity in Industry." As in previous years, the 'school' is being organised by Mr. F. S. Marvin, who will discuss the general problem of industrial unity, while other lectures will deal with the 'Industrial Revolution,' the population problem, science and industry, industrial welfare, and the industrialisation of backward races. Applications to attend must reach the honorary secretary, Miss A. R. Wells, Woodbrooke, Selly Oak, near Birmingham, by June 30.

The Empire Cotton Growing Corporation proposes to award in July next, to candidates of British nationality, a limited number of research and advanced study studentships for work in relation to cotton-growing. Each studentship will be tenable for one year, and of the value of £250 plus a further amount for necessary expenses. The research studentships are intended to enable graduates with a leaning towards research to receive training in research methods from leaders in their subject; the advanced study studentships are to enable men to receive specialised instruction in order to equip them for agricultural posts in cotton-growing countries. Further particulars of the studentships and application forms may be obtained from the Secretary of the Corporation, Millbank House, 2 Wood Street, Millbank, S.W.1. Candidates should state

whether their application is for a senior or a junior studentship. Completed forms must reach the Corporation not later than June 21.

THE Principal Officer's report recently published on the work of the University of London during the year 1926-27 indicates a steady growth. Admissions (including no fewer than 382 graduates of other universities) numbered 7668, as compared with 3852 in the last year before the War and 7577 in 1925; there were 3967 candidates at degree examinations, including 1585 external students; the roll of internal students now comprises 9342 names. Among other interesting new developments the report mentions the institution of chairs of international law at the School of Economics and of bacteriology and epidemiology at the School of Hygiene and Tropical Medicine; a Ph.D. degree in the faculty of music, and diplomas in archæology, public administration, anthropology, and nursing; the extension to University, King's, and East London Colleges of the plan, recently adopted in regard to the Imperial College, whereby alternative papers are set in the Final B.Sc. (Engineering) examination for internal students at the college; and an undertaking to contribute £200 a year for five years towards the maintenance of a British Institute in Paris. In connexion with university extension work were instituted a record of distinguished service and a system of stipendiary lectureships. Many benefactions are acknowledged; among them a gift of £180,000 from the Laura Spelman Rockefeller Memorial Trustees to the School of Economics. The report concludes with a reference to what, for the moment, overshadows all other interests of the University,—the decision to purchase eleven acres of land in Bloomsbury as its permanent home.

THE Association of Teachers in Technical Institutions held its annual conference at Plymouth on June 4. During the past year there have been abundant signs of increased appreciation of the value, both cultural and economic, of technical education, and this formed the chief theme of the presidential address delivered by Mr. H. Hall. The relationships of technical education to other forms of education and to industry and commerce, which have lately undergone investigation by a committee under the chairmanship of the late Lord Emmott, have in the past been associated with a good deal of scepticism as to the validity of the claims of technical teachers that their craft can provide the means of life as well as the means of livelihood; that they have on one hand opportunities not inferior to those of teachers in more academic fields, of developing character and endowing with the capacity for successful civic and social life, and, on the other hand, the power of increasing the capacity of their pupils for efficient service to industry and commerce. That this scepticism has, during the past year, been giving place to a more appreciative attitude is shown by quotations from speeches by the president of the Board of Education and the president of the National Union of Teachers, and from the reports of the Balfour Committee on factors in industrial and commercial efficiency and the Hadow Committee on the education of the adolescent. Mr. Hall ends this part of his address with a plea for definite action, and especially for an increase in day courses as recommended by the president of the Board on Mar. 31, when he said: "So long as employers are content with technical education of this type [evening classes], valuable as it is, they are missing the opportunity of conferring upon the work of their industry the dignity of a craft or profession for which a definite standard of education is required."

Calendar of Discovery and Invention.

June 12, 1712.—In Devereux Court, Strand, are the Grecian Chambers. Until 1843, on this site stood the Grecian Coffee House, which two hundred years ago was a resort for the fellows of the Royal Society. Thoresby the antiquarian, in his diary for June 12, 1712, wrote: "Attended Royal Society, where were present the President, Sir Isaac Newton, both the secretaries, the two professors from Oxford, Dr. Halley and Keull, with others, whose company we afterwards enjoyed at the Grecian Coffee House."

June 13, 1901.—Dewar's work on the liquefaction of gases was referred to under May 28, 1898, when he first liquefied hydrogen. Three years later, on June 13, 1901, he successfully transported through the streets from the laboratory of the Royal Institution to the rooms of the Royal Society no less than a gallon of the liquid gas.

June 14, 1699.—In the *Philosophical Transactions*, vol. 21, p. 228, is the entry: "Mr. Savery, June 14, 1699. Entertained the Royal Society with showing a small model of his engine for raising water by the help of fire, which he set to work before them; the experiment succeeded according to expectation, and to their satisfaction."

June 15, 1919.—Alcock and Whitten Brown, on June 14-15, 1919, made the first direct flight across the North Atlantic from Newfoundland to Ireland. Their machine, now in the Science Museum, South Kensington, was a Vickers-Vimy biplane fitted with two 360-h.p. Rolls-Royce engines. Assisted by a following wind, they flew a distance of 1890 miles in 15 hours 57 minutes at an average speed of 118.5 miles per hour.

June 16, 1657.—The application of the pendulum to clocks was due to Huygens, who on June 16, 1657, presented his first pendulum clock to the States General of Holland. The following year he described his clock in detail in a brochure entitled "Horologium," and fifteen years later gave the theory in his fine work, "Horologium Oscillatorium," published in Paris.

June 16, 1864.—Stokes announced to the Royal Society his discovery that when diluted blood is treated with certain reducing agents, its colour and spectrum undergo a reversible change. "The colouring matter of the blood, like indigo, is capable of existing in two states of oxidation, distinguishable by a difference of colour and a fundamental difference in the action on the spectrum. It may be made to pass from the more to the less oxidised state by the action of suitable reducing agents, and recovers its oxygen by absorption from the air." Of additional interest is that this discovery, fundamentally important for physiology and biochemistry, regarding this animal respiratory pigment, should have been contributed by a mathematical physicist.

June 16, 1874.—The Cavendish Laboratory at Cambridge owes its existence to the Duke of Devonshire, who had been impressed with the need of institutions for experimental research. The Laboratory was formally opened on June 16, 1874, though the inaugural lecture had been given by Clerk Maxwell three years previously.

June 17, 1885.—Among the most famous balloonists of last century was Henry Coxwell, whose last ascent as made on June 17, 1885, when he was sixty-six years of age. Many of his ascents were made for scientific purposes, and it was with him that Glaisher, on Sept. 5, 1862, rose to a height of seven miles. Glaisher became insensible, Coxwell's hands became frozen, and he opened the valve of the balloon by tugging at the cord with his teeth. E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 2.—S. Chapman and A. E. Ludlam: A theoretical discussion of certain elastic constants of calcite and crystalline sodium nitrate. Upper limits are found theoretically for two of the elastic constants of calcite and crystalline sodium nitrate; the calculations are based on the theoretical determinations of the potential energy of these crystals in various configurations. The theoretical upper limits found are larger than Voigt's measured values for calcite but of the same order of magnitude.

R. W. Fenning and H. T. Tizard: The dissociation of carbon dioxide at high temperatures. If mixtures of carbon monoxide, oxygen, and nitrogen are exploded, the explosion pressure is greatest when there is an excess of carbon monoxide in the mixture. If no nitrogen is present the explosion pressure is greatest when the ratio $\text{CO}/\text{O}_2 = 2$, and varies very little with the composition of the mixture near the maximum point. When nitrogen is present, a determination of the composition of the mixture which gives the greatest rise of pressure on explosion, leads to a simple method for determining the dissociation of carbon dioxide at high temperatures. Accepted values for the dissociation of carbon dioxide at high temperatures are much too high.

L. H. Callendar: The influence of boundary films on corrosive action. The surface of metals liable to local corrosion is normally more or less covered with an oxide film; where this film is of higher potential than the metal itself, its distribution determines the location of the primary cathode and anode areas before the metal is in contact with the electrolyte. The distribution of this oxide film is determined by the presence of foreign substances on the metal surface and by irregularities in the surface itself. When metal and electrolyte come into contact, the oxide film is the primary cathode, metal passes into solution at unoxidised parts of the surface, and continuance of this current between cathode film and metal is dependent on the prevention of diffusion of oxygen to the anodes; the original location of cathode and anode areas is likely to be altered by the distribution of oxygen within the solution. Boundary resistance between electrodes and electrolyte is an indicator of rate of corrosion. The normal cathodic oxide film formed in air has little effect, but thicker oxide films formed by heating give high boundary resistance and must tend to retard corrosive action; oxidising electrolytes also retard by increasing boundary resistance. With aluminium, boundary resistance increases with increasing dilution of electrolyte and increasing thickness of any oxide film present on the metal surface.

F. H. Constable: The cause of the colours shown during the oxidation of metallic copper. Evidence has been collected showing that interference is the cause of the colours shown during initial stages of oxidation. The order of production of the colours corresponds with that for interference colours of air films of increasing thickness seen by transmitted light. Fall in electrical conductivity and mass of oxygen taken up per unit area of surface are proportional to the equivalent air thickness of the copper oxide film. The wavelengths of the maxima in absorption or reflection bands, in the spectrum of light reflected from the film, move towards the red as the thickness of the film increases. Finally, general absorption causes blackness of film.

C. F. Elam: Tensile tests on alloy crystals (Parts i., ii., and iii.). Crystals of alloys of aluminium and zinc, containing up to 18 per cent. zinc, have been prepared by the method of straining followed by heat-treatment.

The direction and plane of slip under distortion is in a direction parallel to the diagonal of the cube (*i.e.* in a $\{110\}$ direction) and on an octahedral $\{111\}$ plane, as in aluminium. The alloys showed increased resistance to shear with increased zinc content, and the amount of elongation before fracture was reduced. Crystals were made by melting brass rods, containing 70 per cent. copper and 30 per cent. zinc, in graphite tubes and slowly cooling from one end. In every case these showed that slip under distortion occurred on an octahedral $\{111\}$ plane in a $\{110\}$ direction, as in copper. The elongation before fracture amounted in one case to 168 per cent. Resistance to shear in early stages of extension was slightly less than that of pure copper; final shear-stress was greater.

A. J. Bradley and J. Thewlis: The crystal structure of α -manganese. Westgren and Phragmen have shown that the structure is cubic, the lattice dimensions being 8.894 Å.U. It contains 58 atoms per unit cell. The exact position of the atoms is defined by five parameters. The structure is based on a single body-centred cubic lattice, but each lattice point is replaced by a cluster of atoms, with tetrahedral symmetry. The interatomic distances range from 2.25 Å.U. to 2.95 Å.U., indicating an unequal distribution of electrons between the various atoms.

N. R. Sen: On Fresnel's convection coefficient in general relativity. A simple explanation of Fresnel's convection coefficient is furnished by Einstein's addition law of two velocities. But one would expect to obtain this law in the case of the addition of a small velocity to the velocity of light directly from Maxwell's electromagnetic equations in a moving material medium. We can take a gravitational field and try to obtain solutions of the form $f(x_1 - vt)$ of the modified Maxwell equations, in which there are two electromagnetic tensors F and H , which must also be connected by two more simple relations in a transparent medium. The conditions for the existence of the above plane waves lead to an algebraic quadratic equation for v , whose solution really gives Einstein's addition theorem for the electromagnetic wave velocity and the velocity of the medium.

Helga Pearson: On the skulls of early tertiary Suidæ, together with an account of the otic region in some other primitive Artiodactyla. Starting with the problem of the inter-relationships of the early tertiary Suidæ, it became necessary to reject from this family certain genera usually associated with it. This led to an examination of the otic region in those families, such as the Anthracotheriidae and Hippopotamidae, that are generally regarded as most nearly allied to the Suidæ. Finally, all available early Artiodactyl skulls were examined and an attempt was made to trace the probable course of evolution in this order of the otic region of the skull.

A. W. Greenwood and F. A. E. Crew: Studies on the relation of gonadic structure to plumage characterisation in the domestic fowl. (ii.) The developmental capon and poularde. It is not uncommon for a fowl as it attains maturity to assume the characters of the agonadic bird instead of developing male, or female, plumage and head furnishings. Such a bird is termed the developmental capon or poularde, and is in its characterisation entirely similar to the surgically caponised or ovariectomised individual. Examination of these birds, however, reveals that testicular or ovarian tissue is present though greatly reduced. This may be due to inherent imperfection in the gonadic tissue itself, or to imperfection in the environment (the body) in which it develops.

F. A. E. Crew: The laying hen with cock's plumage. (Part iii.) The cock-feathered laying hen is a female, normal in every respect save that her plumage becomes

as that of the agonadic bird following the moult, as the result of a transient disfunctioning of the ovary (and/or of the thyroid) at this time.

J. W. Trevan: The error of determination of toxicity. Curves expressing the relationship between mortality and dose for various drugs are discussed. It is suggested that, as a definition of toxicity, the average lethal dose for the animal and drug in question should be used. The expression 'minimal lethal dose' should be dropped, because of the various meanings that have been attached to it. The average lethal dose is represented, with sufficient accuracy, by the dose which kills 50 per cent. of a random sample of animals; the statistical error is at a minimum for doses in the neighbourhood of the average lethal dose.

C. K. Drinker and E. D. Churchill: A graphite suspension for intravital injection of capillaries. This fluid possesses qualities essential for physiological injections if employed in perfusion experiments in that the graphite particles are able to mix with blood without agglutinating and to pass through the capillaries without sticking to the walls. When injections of the fluid are made in intact animals, intravascular agglutination of the particles begins in about ten minutes and embolism takes place.

Geological Society, May 11.—P. G. H. Boswell: The Salopian rocks and tectonics of the district south-west of Ruthin (Denbighshire). The district extends southwards and south-westwards from Ruthin, and is bounded on the south by the northernmost fault (or Braich Fault) of the Llanellidan system of east-and-west fractures. It is composed of Salopian beds folded gently on axes running east-north-east and west-south-west. The western half of the area may be regarded as anticlinal; the eastern half shows a synclinal tendency. The dominant faulting is north-eastward in trend. Like the folding and cleavage (which is generally parallel to the fold-axes, with a steep northward dip), it is regarded as Caledonian. North-and-south faulting, which borders the Vale of Clwyd in the north-eastern part of the area, is of post-Carboniferous age. Similarly, the east-and-west Braich Fault limits the fault-system of north-eastern trend to the south, and is also post-Carboniferous. Where the north-east and south-west fault-system meets the north-and-south fractures and the Braich Fault, the beds are much shattered. The Braich Fault is an old fracture, throwing to the north in post-Silurian times, along which tearing movement took place at a post-Carboniferous date.—R. C. Blackie: The geology of the country between Llanellidan and Bryneglwys (Denbighshire). The Llanellidan district consists largely of Lower Ludlow deposits. Wenlock beds are restricted to the area west and north-west of Gwyddelwern, but there is also a small inlier in the centre of the Llanellidan anticlinorium. The Wenlock Series comprises the Denbighshire Grit, the upper limit of which is approximately the summit of the zone of *Cyrtograptus rigidus*; also a series of slab-like beds, representing the zone of *C. lundgreni*. The region came under the influence of the Caledonian movements, which resulted in folding, cleavage, and dominant south-west and north-east faulting. The Llanellidan and Bryneglwys Faults date also from this time. In post-Carboniferous times further movements of a torsional character affected the region, and movement was renewed along the master-faults, together with the initiation of smaller adjustment-dislocations between the Llanellidan and Bryneglwys Faults.

Physical Society, May 13.—J. W. T. Walsh: The theory of luminescence in radioactive luminous com-

pound. From the brightness curves of compounds made with the same luminescent material but with different radium concentrations, the brightness-time relationship is found to be of the form $B = rf(rt)$, where r is the radium content. The brightness curves are in excellent agreement with Rutherford's original theory of the destruction of active centres, provided this be combined with a simple hypothesis as to the cause of the progressive increase in the light absorption of the material which has been found experimentally. This leads to the following brightness-time relationship: $\log\{B/(b+B)\} + kt + a = 0$, where a , b , and k are constants, of which the last two are proportional to the radioactive concentration for any given grade of luminescent material.—E. Mallett: Distortion of resonance curves of electrically driven tuning-forks. Resonance curves with increasing exciting currents show increasing distortion until an unstable state is reached in which the amplitude for a given current over a certain frequency range can have two different values, depending upon whether the frequency has been approached from above or below. The indication here is that a decrease of resonant frequency takes place with increase of amplitude, and also an increase of damping. Static experiments show a departure from the straight line law both in the case of the deflexion of the fork prongs for given loads, and the flux change through the core for a given deflexion of the prongs. The effect of such departures on the equation of motion is considered mathematically, and it is shown that the term depending on the cube of the amplitude is the most important. Another effect of the non-linearity is the possibility of producing fundamental frequency vibrations in the fork by exciting currents of double frequency; distortions of a second type consist of 'coupled circuit' effects: these, at large amplitudes, are modified by distortions of the first type.

DUBLIN.

Royal Irish Academy, May 9.—A. W. Conway: Undulatory theory of two electron orbits. In a previous paper (with G. Keating) the question of the quantisation of certain symmetrical orbits (with certain assumptions as regards the force between the electrons) was dealt with. The resulting negative energy terms were of the enhanced Rydberg form $4R/(n+\mu)^2$ for two different types of orbits. The principles of the wave mechanics of Schrödinger are now applied, and for one type of orbit the terms are of the correct Rydberg form $R/(n+\mu)^2$.

PARIS.

Academy of Sciences, May 2.—Paul Appell: The creation of an institute of physico-chemical biology by M. Edmond de Rothschild.—Mesnager and Veyrier: The determination of the resistance of a structure on a reduced model. In the case of a dam, the effect of the water pressure can be studied experimentally on a small scale model by using a liquid of higher density than water (mercury) and material of smaller resistance than the material actually used on the dam.—G. Friedel: The existence of a salt dome in the Oligocene potash basin of the Haut-Rhin.—Charles Nicolle and V. Lumbroso: A new contribution to the knowledge of natural granular conjunctivitis of the rabbit. In man, and in the Barbary ape, the virus of the rabbit determines a granular conjunctivitis which differs from trachoma by its long incubation and its primitive and principal localisation on the lower eyelid.—Jules Amar: The origin and evolution of cancer. Reasons are given for the view that

cancer is a parasitic disease.—E. Cartan: The topology of simple real continued groups.—D. V. Widder: A theorem on the series of Dirichlet.—J. J. Gergen: Some theorems in Taylor's series having generalised gaps.—André Charrueau: The surfaces of equilibrium relating to a liquid mass of revolution possessing surface tension, in uniform rotation.—Giacobini: The Paris-Winnecke comet. On April 27, at the Paris Observatory, this comet showed as an elliptical nebulosity, major axis 10" to 12", with a marked condensation at one of the foci; magnitude between 12.5 and 13.—Henri George: Two qualities of silica glass. Discussion of the effect of the presence of moisture in the powdered silica before fusion on the properties of the glass.—R. Mesny: The energy radiated by electro-magnetic networks.—Armand de Gramont: A gyroscope kept in motion by an alternating current supplied through its axes of suspension.—Josef Mikuláš Mohr: The relation between the classes of lines (of the spectrum) determined by temperature and the groups of lines determined by pressure.—F. Croze and J. Gilles: The structure of the second order spectrum of nitrogen.—C. Mihul: The electronic configurations corresponding to the emission of the third order spectrum of oxygen.—M. Lambrey and D. Chalonge: The use of the discharge in hydrogen as a source of a continuous spectrum in the ultra-violet. The discharge in hydrogen has already been used as a source of a continuous spectrum in the extreme ultra-violet, but its use has been difficult and the intensity feeble. Details are given for setting up a hydrogen tube working with perfect regularity for long periods and giving an intense continuous spectrum.—P. Gabiano: The alkaline cuprotartrates.—P. Lecomte du Nouÿ: An anomaly in the evaporation of solutions of sodium oleate and of digitonin at high dilutions.—F. Bourion and E. Rouyer: The boiling-point constant of aqueous solutions of potassium chloride and molecular equilibria of resorcinol in this medium.—P. Job: The substitution of ethylenediamine for ammonia in complexes in solution. In most of the complex ammonia salts one molecule of ethylenediamine can replace two molecules of ammonia. With thallium salts ammonia forms the complex ion $Tl(NH_3)_3$. Ethylenediamine gives the ion $(Tlen)$ in which the ethylenediamine replaces the ammonia molecule for molecule.—A. Andant: The application of the spectrography of fluorescence to the examination of organic compounds. Results are given for olive oil, vaseline oil, and castor oil. The method is of analytical value.—Jean Boudoires: The transformations undergone by aluminium bronzes.—G. Gilta: The isomerism of *p*-hydroxyphenylarsenic acid.—A. Demay: Hercynian strata and folds of the Massif of Maures.—R. Bureau: Anomalies of long duration in the propagation of short [Hertzian] waves.—Jacques Maheu and J. Chartier: The botanical origin of the lesser striated Ipecacuanha. This has been identified with *Manettia ignita* of the family of the Rubiaceae.—L. Maume and J. Dulac: The minimum of toxicity of a mixture of two salts with regard to plants.—Lucien Daniel: Two new grafts.—L. Carpentier and G. Thieulin: The direct measurement of the magnitude of the retinal images in the dog and cat.—Ph. Joyet-Lavergne: The proportion of glutathione reduced is a character of the sexualisation of the cytoplasm.—Th. Moreux: Solar activity and certain phenomena of vegetation.—A. Goris and L. Lachaise: The phylactic action of brucine towards strychnine. If 8 mgm. or 10 mgm. of brucine is injected into dogs and one hour later a mortal dose of strychnine, all the dogs survive.—Etienne Wolff: The adaptation of amoeba to saline solutions. Cysts without a membrane.

Official Publications Received.

BRITISH.

- List of Members of the British Astronomical Association, September 1926. Pp. 37. (London.)
 The Lister Institute of Preventive Medicine. Report of the Governing Body, 1927. Pp. 28. (London.)
 Institute of Marine Engineers, Incorporated. Session 1926. Vol. 38: Thirty-eighth Annual Report and Financial Statement and Minutes of Annual Meeting held on Friday, March 11th, 1927, at 6.30 p.m. in the Institute Premises, the Minories, Tower Hill, London, E.1. Pp. cxxii. (London.)
 Proceedings of the London Mathematical Society. Second Series. Vol. 25. Pp. ii+546. (London: Francis Hodgson.)
 Irrigation in the Empire. Memorandum and Questionnaire by Dr. B. A. Keen. Pp. 8. (London: Empire Marketing Board.)
 Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Vol. 14, Part 1, April 1926. Edited by Dr. Joseph Pearson. Pp. 133+12 plates. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.
 The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 34: The Production of the Resting-Spores of *Phytophthora infestans* on Potato Tubers. By Dr. Paul A. Murphy. Pp. 497-412+1 plate. 1s. Vol. 18 (N.S.), No. 35: Some Further Cases of the Production of Diseased Shoots by Potato Tubers attacked by *Phytophthora infestans*, and a Demonstration of Alternative Sources of Foliage and Tuber Infection. By Dr. Paul A. Murphy and Robert M'Kay. Pp. 413-422+1 plate. 1s. 6d. Vol. 18 (N.S.), No. 38: Methylene-Blue (Reductase Test) in Milk Grading. By Dr. M. Grimes, H. S. Boyd Barrett and Dr. J. Reilly. Pp. 497-441. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)
 Western Australia: Geological Survey. Bulletin No. 87: A Geological Reconnaissance in the Central and Eastern Divisions between 122° 30' and 128° 30' E. Longitude and 23° 30' and 28° 15' S. Latitude. By H. W. B. Talbot. Pp. 30+5 plates. Bulletin No. 93: The Geology of portions of the Kimberley Division, with special reference to the Fitzroy Basin and the Possibilities of the Occurrence of Mineral Oil. By T. Blackford. Pp. 56+8 maps. (Perth: Fred. Wm. Simpson.)
 Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge for the Academic Year 1926-1926. Published by Authority. Pp. 74. (Cambridge: Printed at the University Press.)
 Aeronautical Research Committee: Reports and Memoranda No. 1044 (Ae. 281): Full Scale Pressure Plotting Experiments on Hull and Fins of H.M.A.R. 33. By Lieut.-Col. V. C. Richmond. Pp. 26+80 plates. 1s. 9d. net. No. 1073 (Ae. 255): Full Scale Measurement of Lift and Drag

2880.) Pp. 3+8 plates. 4d. net. No. 1050: Reports and Memoranda of the Aeronautical Research Committee published between the 1st January 1925 and the 28th February 1927. Pp. 8. 4d. net. No. 1071: Wind Tunnel Tests of Aerofoil R.A.F. 34. By H. Davies. (A.2.a. Aerofoils-General, 171.—T. 2364.) Pp. 5. 4d. net. (London: H.M. Stationery Office.)
 University of Reading: The National Institute for Research in Dairying. Annual Report for the Year ending 31st July 1926. Pp. 62. (Reading.)

FOREIGN.

- Havsforskningsinstitutets Skrift. No. 28: Översikt av isarna vintern 1919-20. Av Risto Jurwa. Referat: Översikt der Eisverhältnisse im Winter 1919-20 an den Küsten Finnlands. Pp. 80+15 plates. 20 Fmk. No. 37: Översikt av isarna vintern 1914-15. Av Gunnar Granquist. Referat: Översikt der Eisverhältnisse im Winter 1914-15 an den Küsten Finnlands. Pp. 45. 20 Fmk. No. 38: Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1924. Von Gunnar Granquist. Pp. 46. 20 Fmk. No. 39: Die thalassologische Terminfahrt im Jahre 1925. Von Erik Palmén. Pp. 22+1 plate. 10 Fmk. No. 40: Översikt av isarna vintern 1915-16. Av Gunnar Granquist. Referat: Översikt der Eisverhältnisse im Winter 1915-16 an den Küsten Finnlands. Pp. 56. 22 Fmk. No. 41: Havsforskningsinstitutets varksambhet under år 1925. Redogörelse avgiven av Rolf Witting. Pp. 21. 5 Fmk. No. 42: Översikt av isarna vintern 1917-18. Av Gunnar Granquist. Referat: Översikt der Eisverhältnisse im Winter 1917-18 an den Küsten Finnlands. Pp. 40. 18 Fmk. No. 43: Dagliga vattenståndsuppgifter 1924. Av Henrik Renquist. Referat: Tagliche Wasserstandsangaben 1924. Pp. 48. 9 Fmk. No. 44: Översikt av isarna vintern 1924-25. Av Gunnar Granquist. Referat: Översikt der Eisverhältnisse im Winter 1924-25 an den Küsten Finnlands. Pp. 48. (Helsingfors.)
 Akademie der Wissenschaften in Wien: Mathematisch-naturwissenschaftliche Klasse. Anzeiger. Jahrgang 63, 1926. Pp. viii+208. (Wien.)
 Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 17, Part 3: Studies on the Correlations between Morphological Characters, Chromosome-number and Resistance to *Puccinia triticea* in Pentaploid-Bastards of Wheat. By Yoshihiko Tochinai and Hitoshi Kihara. Pp. 138-161. (Sapporo.)
 Svenska Linné-Sällskapetets Årsskrift. Årgång 10, 1927. Pp. i+173. (Uppsala: Almqvist and Wiksells Boktryckeri-A.B.)
 Proceedings of the United States National Museum. Vol. 70, Art. 9: A Review of the South American Two-winged Flies of the Family Syrphidae. By Raymond C. Shannan. (No. 2658.) Pp. 34+1 plate. Vol. 70, Art. 22: Richmond Faunal Zones in Warren and Clinton Counties, Ohio. By George M. Austin. (No. 2871.) Pp. 18. Vol. 71, Art. 3: On a Collection of Orthopteroid Insects from Java made by Owen Bryant and William Palmer in 1909. By A. N. Caudell. (No. 2675.) Pp. 42. Vol. 71, Art. 9: The Digger Wasps of North America of the Genus *Podalonia* (Psammophila). By H. T. Fernald. (No. 2681.) Pp. 42+2 plates. (Washington, D.C.: Government Printing Office.)

Bergens Museums Aarbok, 1926. Hefte 1. Naturvidenskabelig Række. Pp. 21+17+19+10+28+56. (Bergen: A.-S. John Griegs Boktrykkeri.)
Bergens Museum. Aarsberetning 1925-1926 Pp. 90. (Bergen: A.-S. John Griegs Boktrykkeri.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 43, Rapports (Mai 1927). Pp. 50. Bulletin hydrographique pour l'année 1926. Pp. 58. Bulletin hydrographique. Appendice d'observations de l'Allemagne pour 1919-1925 et de la Lettonie pour 1925 et 1926. Pp. 20. (Copenhague: Andr. Fred. Høst et fils.)

Annuaire de l'Observatoire Royal de Belgique. 95^{me} année, 1928. Par P. Stroobant. Pp. 11+231. (Bruxelles.)

Pubblicazioni della R. Università degli Studi di Firenze. Fascicolo N. 43. Osservazioni e memorie del R. Osservatorio Astrofisico di Arcetri. Pp. 51. Immagini spettroscopiche del bordo solare osservate a Catania e Zurigo nel 1922-23. (Appendice al Fascicolo N. 40 della Osservazioni e memorie del R. Osservatorio Astrofisico di Arcetri.) Pp. 8+6 tavole. (Firenze.)

CATALOGUE.

The Indian Empire: being a Catalogue of Books, Paintings and Engravings relating to India, Ceylon, Tibet, Burma, Persia and Afghanistan. (No. 497.) Pp. 78. (London: Francis Edwards.)

Diary of Societies.

SATURDAY, JUNE 11.

ROYAL SOCIETY OF MEDICINE (Laryngology and Otology Sections) (Summer Meeting).—Otolological Session (Clinical Meeting), at 10.—Dr. G. Portmann: The Sacculus Endolymphaticus and an Operation for Draining the same for the Relief of Vertigo.—Cases and Specimens by Dr. A. R. Friel, A. R. Tweedie, Dr. T. B. Jobson, N. Barnett, E. B. Barnes, and others.—Demonstration of Stereoscopic Transparencies of Specimens of the Temporal Bone, by Dr. A. Gray.

BIOCHEMICAL SOCIETY (in Biochemical Department, The Museum, Oxford), at 8.—V. B. Wigglesworth: The Digestion of Carbohydrates in the Cockroach.—P. C. Rament: (a) The Oxidation of Uric Acid by Hydrogen Peroxide; (b) The Estimation of Oxalic Acid in Urine, (c) The Estimation of Oxaluric Acid in Urine.—P. Eggleston and M. G. Eggleston: The Chemistry of Phosphagen.—O. R. Harrington and W. McCartney: The Erlennmeyer Amino-acid Synthesis.—F. Hawking: Synthesis of Vitamin B (Torulin) by Yeast.—H. W. Kinnorsley and R. A. Peters: Use of Norite in the Concentration of Torulin.—P. G. Marshall and H. D. Kay: The Presence of a Nucleotide in Milk.—R. M. Beck and R. K. Cannan: The Peptic Digestion of Gelatin.—J. T. Irving: Metabolism of Glucose by Kidney Tissue in Vitro.—Demonstrations.—A Colorimetric Method for the Determination of the pH of Minute Amounts of Fluid, by V. B. Wigglesworth.—Synthesis of a Bacterial Growth Factor by *Meningococcus*, by J. Orr Ewing and V. B. Reader.—A Simple Fluorophotometer, by J. H. Jeffree and B. T. Squires.

MONDAY, JUNE 13.

ROYAL IRISH ACADEMY, at 4.15.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. A. T. Schofield: Time and Eternity (Annual Address).

INSTITUTE OF ACTUARIES (Annual General Meeting), at 5.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. E. Hurst: The Hydrology of the Nile.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (jointly with the Education Section) (at Royal Society of Medicine), at 8.30.—Dr. S. Ferenczi: The Psychology of the Pre-School Child.

MEDICAL SOCIETY OF LONDON.—Prof. H. Cushing: Annual Oration.

TUESDAY, JUNE 14.

INSTITUTION OF GAS ENGINEERS (Annual General Meeting) (at Institution of Electrical Engineers), at 10 A.M.—J. Wilkinson: Presidential Address.—Seventeenth Report of the Gas Investigation Committee.—Examination of Products of Combustion from Typical Gas Appliances.—Part II. Gas Fires.—At 3.15.—T. Carmichael: Modern Carbonising Economics as exemplified by Results and Working Costs at the Works of the Portsmouth Gas Company.—Eighteenth Report of the Gas Investigation Committee.—Studies in Carbonisation.—Part II. Size of Coal, Admixture, Inorganic Compounds.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir Frederick Gowland Hopkins: The Task of Biochemistry (Croonian Lectures).

MINERALOGICAL SOCIETY, at 5.30.—A. F. Hallimond: On the Atomic Volume Relations in Certain Isomorphous Series.—Dr. P. K. Ghosh: Petrology of the Bodmin Moor Granite (Eastern Part).—Prof. P. G. H. Boswell: On the Distribution of Purple Zircon in British Sedimentary Rocks.—Dr. J. Drugman: On β -quartz Twins from Cornwall.—E. V. Holt and Dr. H. K. Harwood: The Separation of Manganese in Rock Analysis.—Dr. L. J. Spencer: Corundum Twins from Transvaal.

LONDON NATURAL HISTORY SOCIETY (at 40 Winchester House, E.C.), at 6.30.—Sir Frank Baines: Westminster Hall: its History, Architectural Design and Preservation.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Prof. H. Graham Cannon: The Feeding Mechanisms of Crustacea.

RÖNTGEN SOCIETY (Royal Society of Medicine), at 8.30.—Sir J. J. Thomson: The Structure of the Atom and Radiation (Silvanus Thompson Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting) (at North-Eastern Centre).

WEDNESDAY, JUNE 15.

INSTITUTION OF GAS ENGINEERS (Annual General Meeting) (at Institution of Electrical Engineers), at 10 A.M.—G. M. Gill: Ovens as a Gas-Works Carbonising Plant.—Report of the Institution Gas Fellowship on

Influence of the Ash Constituents in the Carbonisation and Gasification of Coal.—Part III. Gasification of Special Cokes: (a) In Steam, J. A. Sutcliffe and Prof. J. W. Cobb; (b) In Carbon Dioxide, W. R. Branson and Prof. J. W. Cobb; (c) In Oxygen, F. J. Dent and Prof. J. W. Cobb.—At 3.15.—J. P. Leather: The Dry Cooling of Coke.—Report of the Refractory Materials Joint Committee.

SOCIETY OF GLASS TECHNOLOGY (in University, Sheffield), at 2.30.—R. Wigginton: Gaseous Fuels for Furnace Heating.—Prof. W. E. S. Turner and F. Winks: The Thermal Expansion of Some Boric Oxide Glasses and some Remarks on the Influence of the Inhomogeneity of the Glass.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. Edmund Clark, I. D. Margary, and R. Marshall: Report on the Phenological Observations in the British Isles, December 1925 to November 1926.—Dr. G. C. Simpson: Past Climates.—H. M. Treloar: The Variation of Eddy Viscosity with Wind Velocity and Season. A Study based on Pilot Balloon Observations at Melbourne.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. E. Richey: The Structural Relations of the Mourne Granites (Ireland).—Dr. W. F. Whittard: The Stratigraphy of the Valentian Rocks of Shropshire: The Main Outcrop.

FOLK-LORE SOCIETY (at University College), at 8.—Miss Eleanor Hull: Female Deities in the British Isles.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—E. Downs: Electro-refining of Silver. EUGENICS SOCIETY (at Royal Society), at 8.30.—Miss Evelyn Lawrence: Intelligence of Institution Children.

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting) (at North-Eastern Centre).

THURSDAY, JUNE 16.

INSTITUTION OF GAS ENGINEERS (Annual General Meeting) (at Institution of Electrical Engineers), at 10 A.M.—J. H. Canling: Some Experiences of Gas Service.

ROYAL SOCIETY, at 4.30

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Dr. Parkes Weber: Early Angioma Seipignosum, with Another Early Case (previously shown) for Comparison.—Dr. G. B. Dowling: Rare Seborrhoea of the Face (Pimple). Acne Agminata.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir Frederick Gowland Hopkins: The Task of Biochemistry (Croonian Lectures).

CHEMICAL SOCIETY, at 8.—I. Vogel: Syntheses of Cyclic Compounds. Part I. Ethyl β -dimethyl Butane $\alpha\alpha\delta\delta$ -tetracarboxylate and Some Cyclobutane Compounds Derived Therefrom.—B. Cavanagh: A New Method of (Absolute) Potentiometric Titration.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.) (Annual General Meeting), at 8.15.—Induction of New President, Prof. J. W. W. Stephens. Presentation of Chalmers Medal to H. L. Duke.—D. L. Fabian Hirst: Rat Flea Surveys and their Use as Plague Preventive Measures.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (Summer Meeting)

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting) (at North-Eastern Centre).

FRIDAY, JUNE 17.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynaecology Section), at 8.—Dr. R. A. Gibbons: The Cause of the Onset of Labour.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (in Department of Zoology and Comparative Anatomy, Oxford), at 8.15.—W. T. Griffiths: Nickel and its Alloys.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at South-Eastern Agricultural College, Wye).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (Summer Meeting).

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting) (at North-Eastern Centre).

SATURDAY, JUNE 18.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.

PHYSIOLOGICAL SOCIETY (at Middlesex Hospital).

ASSOCIATION OF ECONOMIC BIOLOGISTS (at South-Eastern Agricultural College, Wye).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (Summer Meeting).

PUBLIC LECTURES.

SUNDAY, JUNE 12.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Dr. R. E. M. Wheeler: Some of the Ancient Civilisations of Britain.

TUESDAY, JUNE 14.

EAST LONDON COLLEGE, at 5.—Sir Frank Dyson: The Eclipse of the Sun.

UNIVERSITY COLLEGE, at 8.30.—Prof. J. A. Fleming: A Hundred Years of Electrical Engineering.

SUNDAY, JUNE 19.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—C. L. Woolley: Recent Discoveries at Ur.

CONGRESS.

JUNE 16 AND 17.

CONGRESS OF THE INTERNAL COMBUSTION ENGINE (at Padua).



SATURDAY, JUNE 18, 1927.

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Co-operation in Forestry and Forest Products Research.

CONSIDERING the importance of wood and its by-products in the necessities of life, it is strange how comparatively little systematic action has been taken in England to study the constitution of wood-substance and the structure and properties of the different timbers in relation to their uses. Much of our knowledge, whether it be of the chemistry of wood or its mechanical and physical behaviour, is empirical.

Most of the difficulties encountered in connexion with timber are due to its extraordinary lack of uniformity. When anything goes wrong, as, for example, when an aeroplane strut breaks without warning, the first question always asked is: 'Is this a normal piece of wood?' A piece of wood may be regarded as normal or abnormal from several different points of view; for example, in its behaviour under mechanical stress, in either its minute or gross structure, with respect to its treatment during seasoning, or as representing normal growing conditions. The interrelation of these aspects is of very great importance. A timber is usually judged in practice by its mechanical properties, but until our knowledge of the connexion between structure, growth, seasoning, and strength is increased, it will remain impossible to assess the mechanical properties of a piece of timber with any degree of certainty otherwise than by actually breaking a test stick. Further, will the growing conditions which the forester aims at as ideal, produce timber which gives the best results under mechanical tests?

One can only hope to solve such problems by the close collaboration of a number of specialists in different branches of research. The establishment, under the Department of Scientific and Industrial Research, of the Forest Products Research Laboratory at Princes Risborough, within sixteen miles of the Imperial Forestry Institute at Oxford, has opened up a prospect of such collaboration which both institutions have been quick to grasp. These two institutions together provide the much-needed link between the silviculturist on one hand and the wood-user on the other, harnessing science to the task of informing the silviculturist of the species to plant, the quality of timber desired, and the means of obtaining it, and the wood-user of the right timber for the several uses, based on mechanical and physical properties, with the best method of preparing it for use.

In this work the Imperial Forestry Institute is primarily concerned with the living tree, from

the germination of the seed to the felling of the tree for timber: from this point the problems are proper to the Forest Products Research Laboratory, which is concerned with mechanical strength, seasoning, preservation, and manufacture of the timber, and with the investigation of by-products. There exists, however, a common ground, more especially in wood technology, mycology, and entomology. In these three subjects, in order to secure the closest co-operation, the staffs of the two institutions have been practically combined to form a joint section, working on a joint programme, the Forest Products staff being housed at the Imperial Forestry Institute at Oxford.

In dealing with complex problems, it has thus been possible to co-ordinate very different aspects, and the personal contact between the two staffs greatly facilitates the dissemination of information and ideas. For example, a number of independent lines of research, which are being undertaken, have been so arranged that their results may form the basis of an investigation into the problem of 'brashness,' which means an unexpected brittleness in a wood which is not normally brittle; this is a problem of particular importance in aeroplane construction. Other problems coming within this system of co-operative research are the relation between anatomical variation, mechanical strength, and growing conditions; the range of variation consistent with normal mechanical strength; the physical and chemical factors involved in the process of seasoning; the effect of different degrees of fungal attack and the possible relation between insect and fungal attack. In the chemistry of wood-substance, a beginning has been made by arranging for work to be carried out under Sir James Irvine at the University of St. Andrews. This will be closely co-ordinated with the physico-chemical research included in the joint programme of the Laboratory and the Imperial Forestry Institute, especially in its relation to shrinking and swelling.

The problems connected with colonial timbers also can only be effectively solved by a combined investigation in which both the growing of the timber and its utilisation are fully considered. Here the co-operation of the systematist and the wood technologist forms an indispensable link, and is very strong under the existing arrangements. Such a combined scheme has already been put forward, in a joint pamphlet which has been circulated to the Forest Services of those parts of the British Empire which do not yet possess facilities to undertake the work themselves.

An Orthodox View of Witchcraft.

The History of Witchcraft and Demonology. By Montague Summers. (The History of Civilisation Series.) Pp. xv + 353 + 8 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1926.) 12s. 6d. net.

ANY anthropologist into whose hands this book may come will rub his eyes to find himself translated to an atmosphere of theological controversy which might well be that of the seventeenth century. Indeed, he may even go further and ask why a series entitled "L'Évolution de l'Humanité," or, in translation, "A History of Civilisation," in which an impersonally objective treatment of its subject matter might reasonably be expected, should include a book so subjective in outlook as Dr. Summers' "History of Witchcraft and Demonology." It is surely not the function of the student of the development of thought and belief to inquire into the truth or validity of the tenets he examines, or to obtrude his own beliefs; his interest lies in the process of development and its product; he may legitimately be expected to regard them as objective matters of fact, the truth or falsity of their content being irrelevant to his purpose.

Dr. Summers, however, believes in witches, and accepts the witchcraft belief as set forth in contemporary or nearly contemporary accounts and in the reports of witch trials as in the main a true record of a real cult and an actual manifestation of the principle of evil. He believes in the possible efficacy of a malediction. It is true that he acknowledges that the leader of the witches' coven was often proved to be a man—Francis Bothwell, for example, for political and other reasons was suspected of inspiring the Berwick witches who were accused of plotting against James I., and the suspicion is made almost a certainty by his notorious reputation as a 'witch master' when afterwards living at Naples—but he says:

"When God's Ape the Demon can work so successfully and obtain not merely devoted adherents but fervent worshippers by human agency, there is plainly no need for him to manifest himself in person either to particular individuals or at the Sabbats, but none the less that he can do so, and has done so, is certain, since such is the sense of the Church, and there are many striking cases in the records and trials which are to be explained in no other way."

It is therefore with scarcely a feeling of surprise that we read: "anthropology alone offers no explanation of witchcraft. Only the trained theologian can adequately treat the subject." In the

true spirit of the orthodox when a belief in witchcraft was a test of orthodoxy, Dr. Summers gives a long list of fathers of the early Church, theologians, lawyers, and writers on witchcraft who held firmly to the belief in the reality of the existence and powers of the witch; but he might just as well have cited an almost equally long list of those who denied it. It is significant that while references to Sprenger and the "*Malleus Maleficarum*"—the bible of the witchfinder—Boguet, Bodin, and de Spina are frequent, such writers as Scott, Cotta, Bernard, Wierus, Webster, Becker, and Hutchinson, critics of the belief, are barely mentioned, if at all. As most of these writers are English, it may be that Dr. Summers will deal faithfully with them in the later volume in which he promises to discuss the witchcraft belief in its local manifestation in England, France, Germany, and elsewhere.

Bodin, the famous French lawyer and writer of the sixteenth century, defined a witch as "*Sorcier est celuy qui par moyens diaboliques sciemment s'efforce de parvenir à quelque chose*" (a sorcerer is one who by commerce with the devil has a full intention of attaining some end). British jurists laid rather more stress on the existence of a pact with the devil. Virtually there was a general agreement in the witchcraft prosecutions in the fifteenth, sixteenth, and seventeenth centuries throughout Europe and in the American colonies, that whatever may have been the specific act upon which the accusation was brought, witchcraft involved a league with the devil and a renunciation of Christianity. The frenzied fear of the populace was responsible for the cruelty of the duckings and other forms of outrage and the witchfindings of Hopkins and his peers in the small towns and villages of Puritan England and Presbyterian Scotland of the seventeenth century, but it was the animus of the Church against the heretic which brought literally thousands to their death after the issue of the Bull of Innocent VIII. in 1484. It is quite correct, as Dr. Summers points out, that the witchcraft prosecutions did not begin with this Bull; but they increased enormously in number after its promulgation, and it was responsible for the activities of Sprenger and his colleagues in Germany, inspiring them to the authorship of the "*Malleus Maleficarum*," which became the textbook and code of those who emulated their achievements in prosecution elsewhere.

The charges of heresy and witchcraft, it is true, were almost interchangeable, and accusations of witchcraft were brought freely against heretical sects; but it is difficult to accept Dr. Summers'

view that the Bull of 1484 was directed against heresy alone. The various activities of witches are specifically enumerated: the renunciation of the faith is mentioned as an added crime, not as the head and front of the offending, however much importance may attach to it. In order to support his view that the witch as heretic was the object of the Church's attack and that the outburst of witch prosecutions of the fifteenth century was no new thing, Dr. Summers cites earlier Bulls of the popes and refers to earlier heresy trials. Among these he quotes an account of an assembly of Manichees at which the devil appeared. These Manichees were condemned by a synod at Orleans in 1022. But a similar account, almost identical in wording, appears in Walter Mapes about the Paturini, and much the same sort of accusation was brought against the assemblies of most of the many schismatic sects which sprang up about this time. It has all the flavour of a commonplace of ecclesiastical scandal and gossip which was fastened on to any sect that was forced by circumstances to meet in secret. Dr. Summers, however, is convinced of the connexion of heresy and witchcraft. He says:

"The full fury of the prosecution burst over England . . . shortly after the era of a great religious upheaval, when the work of rehabilitation and recovery so nobly initiated by Queen Mary I. had been wrecked owing to the pride, lust, and baseness of her sister. In Scotland, envenomed to the core with the poison of Calvin and Knox, fire and cord were seldom at rest. It is clear that heresy had brought witchcraft swiftly in its train."

In Ireland, on the other hand, for obvious reasons, "the devil's claws were finely clipped."

It is not possible here to follow Dr. Summers in all the consequences which are entailed by this acceptance of the purely heretical character of witchcraft and the orthodox attitude of the Roman Church towards such matters, which almost necessarily involves the view that at the present day witchcraft persists in the celebration of the black mass, satanism, and spiritualism—a conclusion which an anthropologist at least would find it difficult to accept, for psychologically and culturally they are poles apart. It explains why he traces witchcraft back to the Gnostics and the Manichæans, and also why he rejects the anthropological view. His rejection of the contribution of anthropology to the study of witchcraft might carry more weight had it been clear that he is fully aware of what that contribution is. The anthropologist no longer accepts, if he ever did, "devil-worship," the term used by Dr. Summers, as an adequate description of a primitive cult, secret or

other; nor incidentally is 'Bantu' a territorial term. The belief in the witch is widespread in time and space. Possibly its origin may go back to palæolithic times. The animal-headed human figure depicted in the cavern at Les Eyzies, or the leader of the dance in the paintings of Cogul, may be the ancestors of the leader of the coven. Witchcraft exists to-day among both primitive peoples and the peasant populations of Europe. At a time of universal credulity it was elevated by the Church, as a self-protective measure, into a heresy; but that does not place it outside the scope of the science which studies the beliefs of man as objective facts of experience, or remove it from the category of primitive religions, even if it survived only in a mutilated or attenuated form.

In conclusion, although there are still many controversial points upon which it has not been possible to touch, it must be said in fairness to Dr. Summers, and to those who are interested in one of the most extraordinary chapters in history, that notwithstanding the point of view from which the book is written, and the bias which has determined the line of discussion of the origin of the belief, this is the best and most complete account of the witch cult in mediæval and early modern Europe which has been written in recent years.

Tungsten.

Tungsten: a Treatise on its Metallurgy, Properties, and Applications. By Dr. Colin J. Smithells. Pp. viii + 167 + 33 plates. (London: Chapman and Hall, Ltd., 1926.) 21s. net.

TUNGSTEN is a metal which presents so many points of special interest both from the practical and the scientific aspect, that a treatise dealing with it in detail is welcome. From the time when tungstic acid was first prepared by Scheele in 1781 and Bergman soon afterwards isolated the metal, tungsten remained a rare metal, and it only began to assume industrial importance as the result of the work of Oxland in 1847-57. The important position which the metal now occupies, both in connexion with the electric lamp industry and for the production of high-speed tool steel, is an often-quoted but none the less instructive example of the way in which a curiosity of the laboratory may become a valuable product of industry. Apart from this historical interest, however, the properties of tungsten itself are remarkable. The metal, at room temperatures and slightly above these, is chemically inert, and uses based on its resistance to oxidation and to

chemical attack are numerous and important. Its application to electric contacts may be recalled. On the other hand, at higher temperatures, tungsten becomes chemically much more active, combining readily with oxygen and even exerting a strong reducing action on the oxides of other elements. For this reason, both in the manufacturing processes applied to it and in its practical applications at elevated temperatures, it must be kept out of contact with oxygen or other oxidising agencies. As a result we find that it is hot-worked usually in an atmosphere of hydrogen, or maintained in a vacuum or in an inert atmosphere such as nitrogen or argon.

Tungsten is remarkable from yet another point of view. If we take account of what may be termed the 'relative temperatures' of metals, tungsten at room temperature must be regarded as one of the 'coldest' substances which it is possible to obtain; i.e. it is further removed from its melting point than any other metal. Since the properties of metals are closely associated with their 'distance' from their melting points, it is not surprising to find that the mechanical properties of tungsten are correspondingly extreme. At room temperature it is probably the strongest known material, and it can be produced in a ductile condition only in special circumstances. When thus produced, however, it can be cold-worked and work-hardened like other metals, but with this difference, that plastic deformation applied to it at any temperature much below 1500° C. still produces work-hardness. The re-crystallisation normally associated with annealing only occurs above that temperature, which thus corresponds roughly with, say, 550° C. for iron. Finally, tungsten cannot, like other metals, be melted and cast, since its melting temperature is so high that it is not yet possible to obtain a refractory capable of holding molten tungsten. It remains to be seen whether this will yet be accomplished, or whether it will be worth while. Dr. Smithells states that tungsten which has been fused is rendered permanently brittle, but recent work on other metals at least suggests that such brittleness may be due to the presence of traces of inter-crystalline impurities which readily escape detection.

Meanwhile, the process of manufacture of ductile tungsten is again of special interest. Like wrought iron, the metal is brought into a coherent solid form by the high-temperature welding of small particles without previous fusion. The metal is obtained in the form of powder, of the desired degree of purity, and this is welded into the form

of rods by heating the compressed material in an atmosphere of hydrogen and then 'swaging' it while hot. The rods thus produced are 'sintered' by heating them electrically by the direct passage of a heavy electric current, and the material thus consolidated can then be worked down, while hot, by further hammering. Ultimately it can be drawn down to exceedingly fine wire in the cold. Perhaps the most curious fact of all is that such wire shows a considerable degree of ductility, but is rendered completely brittle by heating it up to or beyond 1500° C. The proximate explanation is that in the cold-drawn wire the crystals are elongated into long fibre-like bodies, so that bending or twisting of the wire implies deformation of the crystals themselves, but little or no relative motion between adjacent crystals. After annealing, the crystals resume an equi-axed arrangement, and any plastic deformation implies considerable relative movement of the crystals with the result that, at room temperature, rupture immediately occurs. This phenomenon has been interpreted, both by Z. Jeffries and the present writer, in terms of the 'amorphous cement' theory, according to which there is a thin layer of non-crystalline metal between adjacent crystals. At temperatures very far below the normal melting point of the metal, this amorphous layer is brittle and incapable of even a minute amount of flow. A similar phenomenon occurs in iron at very low temperatures.

The question just briefly discussed is an example of the way in which the behaviour of tungsten is apt to become the testing-ground of theories of the structure and behaviour of metals in general. In fact, a considerable portion of Dr. Smithells' book, and perhaps the most interesting portion of it, is devoted to an account of a series of researches of a general fundamental nature in which tungsten has served as the material for experiment. In view of the difficult technique, often involving the use of very fine wires and of exceedingly high temperatures in high vacua or in carefully controlled atmospheres, it is surprising to find the degree of success which these investigations have attained. The researches of Goucher and of Smithells himself are excellent examples. The only misgiving is whether tungsten, which differs in so many remarkable ways from other metals, is the best choice for work of this kind. No doubt the most fundamental phenomena are common to all metals, but each of them has its own peculiarities, and tungsten perhaps more so than the majority.

Dr. Smithells' book deals with the various
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matters already mentioned, and many others bearing on the manufacture, properties, and applications of tungsten in a lucid and interesting manner. The matter of the book is selected in a way which speaks at once of the fact that it is the work of a man writing on his own subject, largely on the basis of direct personal knowledge, and the book is to be valued accordingly. The only section to which this does not apply so fully is that relating to the use of tungsten in alloy steels. No doubt this section has been included for the sake of completeness, but it is not on the same level as the rest of the book. One can scarcely blame Dr. Smithells because he is not also an alloy-steel metallurgist, but it might have been wiser to omit this section.

Finally, the photo-micrographs of tungsten which are given in the book deserve a word of praise. They frequently represent sections of very thin wire wound in spirals and have been obtained by an ingenious technique used with great skill. Fortunately, the structures encountered in a pure or nearly pure metal like tungsten are sufficiently simple to be readily understood by the technical reader even if he is not a trained metallographer. On the whole, Dr. Smithells' book is to be commended as a clear and well-written monograph on a subject of great interest. W. ROSENHAIN.

Parasites and Man.

- (1) *Contributions from the Harvard Institute for Tropical Biology and Medicine, No. 4. Medical Report of the Hamilton Rice Seventh Expedition to the Amazon, in conjunction with the Department of Tropical Medicine of Harvard University, 1924-1925.* Members of the Medical Expedition: Prof. Richard P. Strong, Prof. Joseph C. Bequaert, Prof. George C. Shattuck, Ralph E. Wheeler. Pp. xvi + 313 + 70 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 20s. net.
- (2) *Animal Parasites and Human Disease.* By Dr. Asa C. Chandler. Third edition, revised. Pp. xiii + 573. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 22s. 6d. net.

(1) **T**HIS attractive volume, printed and illustrated with the expensive excellence that is found so frequently in American publications, is a prelude to adventure in a scientific sense rather than a record of completed researches. While this is true up to a point of the actual work

accomplished, the summing up of the knowledge concerning all the matters touched upon is vividly and skilfully done, so that the reader is presented with the state of knowledge in connexion with the matter in hand in relation to the particular experience and contribution made by the members of the expedition. This is well shown by the very interesting account of yellow fever. Scarcely any cases occurred during the period spent by the expedition in Brazil; the preventive measures, and probably also a spontaneous remission, have resulted in the almost total disappearance of the disease. The writer, however, summarises the studies carried out on the last epidemic at Bahia in 1923, and concludes that the evidence incriminating *Leptospira icteroides* was strengthened and the identity of the yellow fever occurring in Palmeira and Bahia with that which is found in Mexico, Peru, and Colombia was established.

Among the medical matters investigated, the chapter on malaria and splenomegaly is of particular interest. Malaria, in spite of quinine and of all the knowledge that has been accumulated in the last thirty years, remains the most prevalent and serious disease of Amazonia, as indeed of practically all tropical and many subtropical countries. It is true even now that the disease is accepted fatalistically in countries much more civilised and better administered than that traversed by the expedition. The workers show the wide experience that they bring to the problem, which is well handled, and the ravages of the disease as an agent of human degradation and of actual depopulation of considerable areas are forcibly and eloquently described.

The chapters dealing with insect life are, as might be expected, of great interest, tropical South America being a naturalists' paradise in this respect. Simulium and Tabanus were found in large numbers, and are reported upon in some detail. The summing up of the rôle of Tabanus species in the transmission of disease, especially protozoan diseases such as trypanosomiasis, is judicial and well informed. The problem of the transmission of the trypanosome of Mal de Caderas remains, however, unsolved.

The expedition, as has already been shown, had a happy and catholic taste in knowledge, and there is an excellent account of a new dipterous fly *Malacophagula neotropica* (Bequaert), parasitic in a snail. This chapter also gives an account of the arthropod enemies of snails.

(2) If the report of the Hamilton Rice expedition cast its net in a wide and leisurely way into a sea

of tropical life, and brought back a mixed catch which is set out with a truly scientific interest in knowledge for itself, the second book to be considered deals with the wide range of its subject in a totally different spirit.

In "Animal Parasites and Human Disease," Dr. Chandler takes his title to heart from the first page, and we are considering animal parasites and animal life strictly from the view-point of the doctor and the sanitarian. The author knows what he is about, and the preface states the position with admirable clarity. It purports to give the results of scientific research in this particular field in such a way that it shall be useful to those who seek to apply them to practical problems. Dr. Chandler is inclined to reprove the scientific worker for his failure in propaganda, but this vivid, condensed, and readable treatment of the subject is itself a proof that the task of exposition is probably better executed by those who are applying the fruits of inquiry rather than by those whose energies are absorbed in the pursuit of new knowledge.

There is here quite frankly a different attitude towards knowledge, and the energetic insistence of this type of statement requires gifts which differ from those usually possessed by the research worker.

The book succeeds in its aim. It contains an enormous amount of information; it deals with all the protozoan parasites of man, their life-histories, means of transmission, and with the history of the insect vectors—this last section is particularly well done considering the scope of the book. All the spirochaetes of man are described; all the 'worms' parasitic in man, with a brief chapter on leeches, and all the arthropods which are either parasites of man or suck his blood, are included; and all this is achieved within the compass of 528 pages. It is in the main a very accurate and fair presentation of the case, and if there are some rather sweeping generalisations and a slightly optimistic sense of progress and achievement, as, for example, in the account of malaria, it is nevertheless a sound and valuable book and excellently suited to the reader for whom it is designed.

One wonders if such doubtful forms as the Chlamydozoa and *Cyclasterion scarlatinae* are worth including in this book, but the fact that they are mentioned gives a measure of the completeness with which the author has dealt with the subject.

These two books are an interesting comment upon each other, for the Hamilton Rice report reveals how lamentably the use of knowledge lags behind its possession.

Cainozoic Plants.

British Museum (Natural History): Catalogue of Cainozoic Plants in the Department of Geology. Vol. 1: The Bembridge Flora. By Eleanor Mary Reid and Marjorie Elizabeth Jane Chandler. With a section on the Charophyta, by James Groves. Pp. viii+206+12 plates. (London: British Museum (Natural History), 1926.) 15s.

THE appearance of the first volume of the catalogue of Cainozoic plants in the British Museum is a noteworthy event. Catalogues of the older plant remains have already appeared, but the great and valuable stores of Tertiary plants in the national collections have received scant attention.

The plant remains of this period are of great interest but present exceptional difficulties; they are derived chiefly from Angiosperms, often closely resembling modern genera or even species, but usually are represented by leaf impressions only. These are so difficult to identify that many eminent botanists have regarded the task as practically impossible, and have thrown doubt upon the validity of much of the work already done. If, however, we could be sure of the identity of the remains which have come down to us, we should have material of great value for the solution of some of the difficult problems of plant evolution and distribution.

In the present catalogue a number of species are described, identified, and established on grounds which are far more secure than those which Hooker and others have criticised. In the Bembridge beds there are not merely leaf impressions but also the remains, often very well preserved, of seeds and fruits; many of these can be compared so closely with the seeds and fruits of living plants that it is impossible to doubt the correctness of their determination. The cuticle-structure of some of the leaves is preserved also, and in several cases their identification may be taken as firmly established.

Among the more interesting forms described may be mentioned a new species of *Azolla*, founded on astonishingly well-preserved material, and most interesting in view of the re-establishment of this genus in England in recent years. Dr. Florin has aided the authors in establishing the presence of a new species of *Araucarites*, while *Sequoia*, *Cupressus*, and *Pinus* were also present. The majority of the Angiosperms have been compared with plants now existing and have been given suitable generic and specific names, but others which could not be matched with any known living forms are described and placed in the non-committal genera *Carpolithus*

and *Dicotylophyllum*. The remains of Charophyta are abundant in the flora and have been treated in a separate section by Mr. James Groves, the well-known authority on this group.

One of the most interesting parts of the volume is the introduction, in which, among other matters, the authors give an analysis of the flora and compare it with other fossil and modern floras. It is shown that the Bembridge flora has a greater affinity with the plants living to-day in eastern Asia and North America than with the present European flora, and the authors point out how greatly the recent work on the floras of China and the neighbouring lands affects the determinations and conclusions of the earlier writers on Cainozoic plants.

H. H. T.

Our Bookshelf.

(1) *Wireless Pictures and Television: a Practical Description of the Telegraphy of Pictures, Photographs, and Visual Images.* By T. Thorne Baker. Pp. x+188. (London: Constable and Co., Ltd., 1926.) 6s. 6d. net.

(2) *Television (Seeing by Wire or Wireless).* By Alfred Dinsdale. Pp. 62. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 2s. net.

(1) APPLIED photo-electricity has perhaps developed more rapidly than any other branch of applied physics. The discoveries of outstanding importance which have resulted from photo-electric observations have stimulated the production of improved apparatus, and this has had a healthy reaction upon practical applications. Of these, telephotography and television are among the most interesting. Of the former, Mr. Thorne Baker was one of the most distinguished pioneers, and it is well to have a book on the subject from his pen. The various methods of picture transmission, such as those of Bakewell, Caselli, Charbonelle, Korn, Belin, and others, are described, but considerably more might well have been said about the code method by which Sanger Shepherd transmitted the race for the America Cup. A great deal is naturally said about selenium, and most of it correctly, though the date of discovery of its light-sensitiveness is given as 1861 instead of 1872, and the very prevalent mistake is made of describing it as particularly sensitive to red light, the great response to which is solely due to the abundance of energy in the red end of the spectra of most terrestrial sources.

The successes achieved by Korn with his selenium transmitter in 1907 have almost been forgotten; the speed was five seconds per line, in spite of the 'lag' of selenium. Portraits were transmitted between Paris, London, and Berlin, of a quality suitable for newspaper reproduction. More recent methods, employing photo-electric cells with a million-fold amplification, may be somewhat speedier but scarcely give a better quality, though giving more detail. The method worked out by Mr.

Herbert Ives, of the American Telegraph and Telephone Co., is particularly interesting in view of the fact that it has recently been successfully applied to television. The difficulty of synchronisation is in this case got over by phonic wheels at the sending and receiving stations, both controlled by the same tuning fork.

(2) Mr. Dinsdale's booklet purports to give a general statement of the problem of television and the various attempts to solve it. Much is said about the results achieved by Mr. J. L. Baird, and said in a rather rhetorical manner, without, however, giving sufficient data to judge of the originality of the method adopted. But at a time when the solution of the problem is being achieved simultaneously along different lines, it is useful even to have a partial description of one of the successful systems. E. E. F. D'A.

The Yearbook of the Universities of the Empire, 1927. Edited by Walter H. Dawson. Published for the Universities Bureau of the British Empire. Pp. xii + 858. (London: G. Bell and Sons, Ltd., 1927.) 7s. 6d. net.

A BOOK such as this falls, usually, into one of two classes. It can be an indispensable (if tiresome) list of names to which are attached groups of more or less intelligible statistics, a somewhat dull reiteration of policy, an urbane or challenging record of things accomplished, some indigestible lumps of 'useful information,' and a dissertation which veils but thinly the propagandist hand. In this case it goes so swiftly to the reference shelf that, almost in the same breath, we bid it welcome and farewell. Alternatively, it may present all the names, statistics, records, and useful information, and still retain the subtle quality of the dictionary. We take it up to seek some special point of interest and find ourselves absorbed delightfully by old things which appear in new light, and by new things which stimulate and surprise.

It is in the second class we would place the present volume. It is an admirable condensation of authentic information which could otherwise be obtained only by research in individual university calendars—volumes comprising in their total some 50,000 pages. From each of these, extracts concerning personnel, organisation, regulations, and recent activities have been taken and arranged in an interesting and easily accessible form.

With regard to the details of the libraries, laboratories, degrees, scholarships, publications, etc., of each university, we need say no more than that no essential point appears to have been neglected. We must not fail to note, however, that, especially in the appendices, information appears which helps vastly to see how the conception of university work is growing and to note the widening of its function in modern life. One appendix gives lists of the titles of theses accepted for research degrees. Another sets out a remarkably full list of centres of research outside the universities. Details of professional schools show how the advanced work in technical and other colleges is becoming identified with the university.

Descriptions of varied careers give some indication of the delimitation of university aims. Finally, an account of federations and foreign universities cannot fail to leave some impression of the vast possibilities of international understanding yet to be explored.

Beyond the Milky Way. By George Ellery Hale. Pp. xv + 105. (New York and London: Charles Scribner's Sons, 1926.) 7s. 6d. net.

THIS little book is a continuation of the series of books by Dr. Hale, of which "The New Heavens" and "The Depths of the Universe" were the first representatives. Like those volumes, it forms an *édition de luxe* of three articles which originally appeared in *Scribner's Magazine*: their titles are—"The Oriental Ancestry of the Telescope"; "Heat from the Stars"; "Beyond the Milky Way." They are plentifully illustrated by excellent photographs and diagrams, and the volume in every respect reaches the high standard set by its predecessors.

The contents of the chapters have already been separately noticed in NATURE on their first appearances, so that little of a descriptive character need be said. It is unnecessary also to comment on the accuracy and lucidity of style of a book by Dr. Hale. His main purpose in this excellent little series is "to tell of some of the principal advances of my associates, with such historical background as to render their significance clear," but that he is not rigidly restricted by the terms of this statement is shown by the fact that the first chapter of the present volume has been constructed, as he says, from material gathered chiefly in Egypt and England. The book will be found useful, not only by the general reader, for whom it is evident that it has chiefly been prepared, but also by workers in astronomy who often feel the need of authoritative statements on matters of current research, disentangled from the mass of detail in which they are necessarily involved in the original publications. A new attitude to the problem of variable stars is inevitably induced in the reader by the direct statement that "while to the eye X-Cygni is 10,000 times as bright at maximum as at minimum, the total radiation as measured with a thermocouple undergoes a variation of only 1.7 times." We hope that Dr. Hale will continue to enrich the literature of astronomy by further additions to this admirable series.

An Introduction to the Study of Map Projections. By J. A. Steers. With a Foreword by F. Debenham. Pp. xxiii + 189. (London: University of London Press, Ltd., 1927.) 7s. 6d. net.

THE author of this book, realising that geographers are not necessarily mathematicians, has attempted to explain the subject of map projections. The construction of the map has frequently been beyond the geographical student. The mathematician could arrive at an understanding of this section, but to others it was a morass where few found the path, and the majority had to be content with an imperfect notion. This book, without any pretence to finality, provides a guide for such geographers. It is introductory in the true sense.

It may be urged that the book would be improved by dealing with difficulties as they arise, instead of deferring them—for example, in the zenithal equidistant, the equatorial and oblique cases are postponed to p. 154, whilst the simple polar case is treated on p. 54. The answer to this is that the difficulty is left until the reader is able to deal with such problems. The lucidity of the constructions, geographical and trigonometrical, and the liberal use of figures (even simple cases are illustrated) will be appreciated.

The author might realise that having used a light inside the sphere to project, it is a difficult task to “bring back the shadows.” Again, the definition of latitude (p. 19) lacks precision. It is unfortunate that the determination of latitude and longitude was not incorporated into chap. iii., and some of the figures would be improved by the use of perspective. Figs. 12 and 13 illustrate this; the latter gives a much better impression of the sphere. Visualisation is a great help to any reader. The book will be welcomed as a sound basis for the study of map productions.

J. ELING COLECLOUGH.

The Statesman's Year Book: Statistical and Historical Annual of the States of the World for 1927. Edited by Dr. M. Epstein. Sixty-fourth Annual Publication. Revised after Official Returns. Pp. xxxviii+1519. (London: Macmillan and Co., Ltd., 1927.) 20s. net.

FOR the first time for forty-three years this volume makes its appearance without the name of Sir J. Scott Keltie on the title-page. The joint editor for the last seventeen years now has sole control. The volume is arranged on the plan of past years, which it would be difficult to improve, and, as usual, has been revised in every detail according to the latest returns available. With its fifteen hundred pages it is a marvel of condensation and convenient size. The recent census figures of the Irish Free State, Northern Ireland, South Africa, New Zealand, France, and Egypt are included. Improvements have been made in the section on Morocco in order to bring out the distinction between the French, Spanish, and Tangier zones. Additions are also made to the Russian section, particularly in the portion relating to central Asia and the Caucasus. The introductory tables include various statistics of world production, and there is also a section on the League of Nations. The three coloured maps illustrate African railways and political jurisdiction, the Egypt-Cyrenaica boundary, and the boundaries between Nejd, Trans-Jordan, and Iraq. The valuable bibliographies contain the most authoritative works of reference on every State.

Our Early Ancestors: an Introductory Study of Mesolithic, Neolithic, and Copper Age Cultures in Europe and Adjacent Regions. By M. C. Burkitt. Pp. xii+243. (Cambridge: At the University Press, 1926.) 7s. 6d. net.

IN attempting to give an account of the development of civilisation from the end of the palæolithic age to the bronze age in Europe and adjacent

regions, within the compass of this small volume, Mr. Burkitt has essayed a very difficult task—difficult in more ways than one, for the material does not lend itself easily to systematic treatment. It has not been worked over and classified to the same extent as the material of the old stone age, and in the later stages the problem of dealing with a multiplicity of detail of which the bearing is often still obscure is complicated by ethnological questions to which the answers are still very much at the hypothetical stage. All credit is therefore due to Mr. Burkitt for the success with which he has carried out his task, even though in its later pages his book suffers from over-condensation and lack of space for adequate discussion of many doubtful points. Probably to most of his readers much of the material relating to the copper and bronze age will be seen in a new perspective, while the chapter on art brings together material which is usually scattered. It gains greatly in significance by the author's method of treatment.

Delphos: the Future of International Language. (To-day and To-morrow Series.) By E. Sylvia Pankhurst. Pp. 95. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2s. 6d. net.

THE student of this recurrent and ever-present problem will welcome this extremely handy analysis of all hitherto attempted universal languages, contributed by Miss Pankhurst to the “To-day and To-morrow” series of opuscula. Both the purely ‘invented’ languages and those based upon existing languages are dispassionately discussed and explained, and the natural conclusion arrived at is a return to that form of the original universal language—Latin—which has been standardised by Sig. G. Peano under the name ‘Interlingua’ and already possesses a well-established academy. The examples given speak eloquently for themselves, for ‘Interlingua’ does not require to be ‘learnt’ by any ordinarily educated person. Any one with a superficial knowledge of elementary Latin can produce his own ‘Interlingua,’ and use it in case of need. E. H.-A.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1926. Edited by Dr. M. Epstein. Pp. xiv+341+192. (London: Longmans, Green and Co., Ltd., 1927.) 30s. net.

THIS admirable volume is arranged on the usual lines. Part I. contains summaries of British foreign and imperial history, the arrangement under States greatly facilitating reference. Part II. includes a chronicle of events, an obituary of the year with short biographies, and a retrospect of literature, science, art, finance, and law. No aspect of the year's history is omitted, and the balance between different interests is well kept. The twelve pages in which the science of the year is recorded mention the most important researches and publications. Among the public documents printed in full is the text of the Report of the Inter-Imperial Relation Committee that was adopted by the Imperial Conference in November 1926.

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though in the long run economic, entails heavy initial expenditure. On the other hand, to place townsmen on the land as isolated units and without adequate training and supervision is to court failure.

The comments upon the part education should play go to the very root of the matter. There is nothing to be gained by shutting our eyes to the fact that since the foreign migrant has a far more highly developed 'land sense' than the British migrant, less has to be spent upon looking after him during his early years. So far as I am aware, foreign Governments do not, and have no need to, give grants in aid of migration. But we have to deal with the fact that the drift to the town is more accentuated in the case of the Anglo-Saxon than with other nationals. Considerations of national safety demand that that tendency should be combated.

If we are to develop the empty spaces of the Empire by men of our own race, we must take the necessary steps to guide cultivators of the soil to those areas. A high degree of organisation and the full co-operation of all the Governments of the Empire is called for; and such organisation will cost money. We must maintain balance. Such effort does not preclude the migration of thousands of men who will not go upon the land, but it will be fatal if the agricultural side be overlooked.

CHRISTOPHER TURNOR.

Stoke Rochford,
Grantham, May 31.

THE main criticism contained in the article in NATURE of May 14 was that the report of the Overseas Settlement Committee did not deal with those very points on which members of Parliament should be informed. The report should have contained the information given in Mr. Turnor's interesting letter, that the Dominions cannot at present absorb all those of our people willing to migrate, and that New Zealand absorbs, per head of population and *pro rata* for her area, more migrants than any other Dominion. Possibly there would be some difficulty in attempting to deal with certain of the factors enumerated in these columns which influence overseas settlement, but most of them could be dealt with—in particular, the inter-relationships between overseas settlement and trade with the Dominions, and the programme of development and other development projects put forward by the Dominions which must at some time have been discussed by the Committee. We cannot altogether agree with Mr. Turnor that it is inexpedient to deal with the causes operating against the migration of our peoples to South Africa. They are not sufficiently well known to members of Parliament. Mr. Turnor suggests that migrants of other nations do not receive financial assistance. Possibly foreign Governments do not give direct assistance, but it is a fact that one of the principal objects of the 'Deutsche-Kolonialgesellschaft' is to afford financial support to German emigrants. With Mr. Turnor's concluding sentences we are in entire agreement. That is why regret was expressed that the report did not deal adequately with problems which face the Committee.

THE WRITER OF THE ARTICLE.

Measurement of Evaporation of Sea Water.

MANY methods have been devised for the investigation of the evaporation of sea water, but of them all only those can be applied aboard a ship in which errors caused by the rolling of the ship are prevented. Therefore the method invented by Dieulafoy and modified by Penck and Merz has largely come into

use. The authors mentioned measured the quantity of evaporated water by observing an increase of the concentration, or density, of the salt solution.

Evidently, however, such an increase must always be very small, because the concentration itself of the salt in the sea water is usually equal to 30-37 per thousand. For example, Merz and Wüst were obliged to wait 12-24 hours before it was possible to make a good observation of the increase of concentration. During such a long time all the meteorological conditions may be altered and the temperature of the evaporating water will change.

The simple method which I describe here is free from all these defects. It is based on the observation of the cooling of water caused by evaporation.

The sea water must be poured into a so-called Dewar vessel of a special form, represented in Fig. 1.

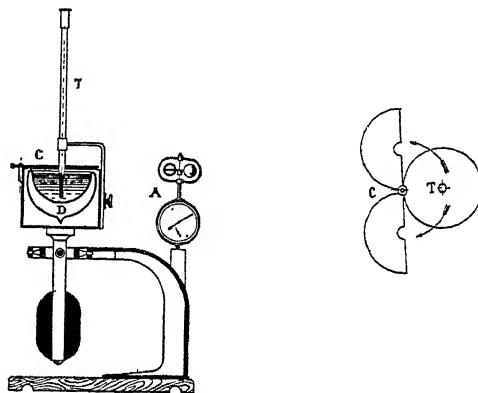


Fig. 1.

The thermometer T gives the initial temperature, when the instrument is closed with a cover C . When the latter is opened the water will begin to evaporate through the action of the wind blowing over its surface. The latent heat of evaporation, specific heat of water, the volume of the vessel, and the area of the water level are known. It is easy, therefore, to calculate the quantity of water which evaporates in 1 sec., per unit area, but only if the mean temperature of the water—before and after evaporation—is equal to that of the air. The interval of time sufficient for the perceptible cooling of the water usually *does not exceed a few minutes*, the thermometer scale showing not smaller parts than fifths of a degree.

The temperature of water is usually higher than that of the air. In such cases one must draw the curve of cooling (Fig. 2). The ordinates of this diagram represent the temperature of the water, and abscissæ either the time or the "distance which the air-particles travelled in the wind." This latter case occurs when the velocity of the wind varies strongly during a short period of time. (For further details on this question see my article mentioned below.)

We will now consider only the case of constant velocity of the wind. Let us denote the temperature of the water by t (t_0 being the temperature of the air) and the time by T . Then it is evident that the velocity of evaporation is proportional to dt/dT , calculated for a point of the curve, where $t = t_0$. To the same quantity $(dt/dT)_0$ is proportional the quantity of heat which is lost by the water. If we calculate analogous quantities

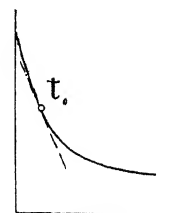


Fig. 2.

for other points of the curve (in Fig. 2), we shall obtain data for the study of the *thermal interchange* between the sea and the air: if the temperature of the former is greater than that of the air, there will be a more rapid cooling of the water; conversely, the cooling down will be retarded. From such observations can be deduced the law of thermal interchange, a law of very great importance for geophysical problems.

A great number of observations have been made by me from the Black Sea, over the Mediterranean, Red Sea, Indian Ocean, to the China and Japan Seas, from July 1925 to March 1927. The results of the measurements of the evaporation and thermal interchange will appear in *Gerlands Beitrage zur Geophysik*. The instrument used for these measurements was suspended on Cardan-rings, as is shown in Fig. 1, *A* is the anemometer, placed on the same level with the water in the vessel.

With an analogous instrument one can measure the evaporation of water immediately from the level of the sea or of the lake; in this case it must float in the water so that the edges of the Dewar vessel just touch the water-level. Thus it is possible to find the connexion between the evaporation from a vessel on board a ship and the evaporation in natural conditions.

It is understood, of course, that such experiments can be made only when the water is sufficiently calm.

WAS. SHOLEJIKIN.

Physical Institution,
3 Miusskaja 3, Moscow.

Transmission of Heat through a Brick Wall.

THE letter on "Solar Radiation and Diathermancy" in NATURE, Mar. 26, 460, seems worthy of comment. Radiation, which Mr. Dufton thinks must be called into account to explain the rapid transmission of heat through a brick wall as shown by his curves, is, of course, a possible factor in heat conduction. It appears to us, however, an unlikely one in this case, so we have tried some calculations on the transmission to see if it cannot be explained on the basis of ordinary conduction, assuming reasonable values for the thermal constants.

Fortunately for the purposes of calculation a ladder has, by its shadow, impressed upon the curves at one point a very fair sine periodicity (period T about 1650 seconds), and the velocity V with which the maximum or minimum phase penetrates into the material can be computed. The thermal diffusivity (conductivity divided by product of specific heat and density) is connected with V and T in this case by the relation $V^2T/4\pi$. V may be determined by plotting maxima and minima against time. The points up to a quarter of the whole thickness give a very fair straight line, and even the total thickness curve gives points on the same line if a reasonable assumption is made in identifying corresponding maxima. The half thickness curve does not fit at all, but little weight is given these two latter curves as, strictly speaking, the simple theory does not apply so well to them.

The average velocity comes out 0.0072 cm./sec., which gives a diffusivity of 0.0068 c.g.s. units. This is within the range 0.005 to 0.007 usually found for brick. Accordingly we feel that, while there are certain things about some of the curves which require further explanation, there is no good reason for bringing in other than ordinary conductivity considerations in accounting for the penetration.

L. R. INGERSOLL.
JOHN BARDEEN.

University of Wisconsin,
Madison, Wis., May 7.

No. 3007, VOL. 119]

A New Type of Primary Cell.

WITH reference to the new type of primary cell described by Jindal (NATURE, April 30, p. 639), a description of a two-fluid 'oxidation' cell recently constructed by me may prove interesting.

Zinc, in a saturated solution of ammonium sulphate, and carbon, in an acidified solution of potassium permanganate, form the constituents. In order to maintain the permanganate solution saturated, a layer of the crushed salt is placed at the bottom of the containing vessel.

This cell has an E.M.F. of 2.16 volts, with an internal resistance of 0.5 ohm approximately, for currents varying from 0.6 to 0.2 ampere.

On a simple test, with continuous discharge for twenty hours, the output remained constant for eight hours at 0.3 ampere, afterwards decreasing to 0.2 ampere.

At the conclusion of the test the initial E.M.F. was quickly reached.

Practically no polarisation occurs, and the amount of zinc dissolved is inappreciable.

The cell possesses many advantages over the Daniell elements used in laboratories, and should prove useful, in a modified form, as a source of high tension supply in wireless work.

D. R. BARBER.

Department of Physics,
University College, Exeter,
May 13.

The Industrial Revolution.

MISS BUER's letter in NATURE of May 7 removes the difficulties which I felt in accepting the reviewer's statement that the rise and population in England after 1750 was due to the introduction of inoculation and a consequent decline in infant mortality.

I am, however, mainly interested in the industrial history of Great Britain in the first half of the eighteenth century, and here I still think that Miss Buer has underestimated the influence of the Colonial trade upon developments in the west of England. In her chapter on commerce Miss Buer says that "Bristol and Norwich were stationary and Liverpool had hardly begun to be." The chroniclers of Bristol (Nicholls and Taylor, for example) do not support this statement. Bristol, it would appear, had been growing in importance long before 1750, and this prosperity had extended beyond the City walls. In 1756, Dean Tucker estimated that the proportion of iron manufacturers—that is, smiths to iron-makers—was two thousand to one. The former were using largely American bar iron, but the iron industry had already moved from the Weald to the west to be in a position to supply this growing market. Hence it is probable that there was in the first half of the eighteenth century a considerable redistribution of population in Great Britain—some depopulation by the southern counties being more than offset by an increase in the western area.

E. WYNDHAM HULME.

Old House,
East St., Littlehampton.

A Convenient and Rapid Method of Sampling.

IN a recent investigation carried out by the writers, with Mr. E. B. Wedmore (see paper read before the Institution of Electrical Engineers on April 7, entitled "A Contribution to the Study of the Number of Tests required to establish the Rupturing Capacity of an Oil Circuit Breaker"), it was desirable to

perform some sampling of a population of Pearson's Type I. As the method used is a simple one and apparently new, and appears to give satisfactory results, a description of it may be of interest.

A stout cardboard disc was accurately subdivided into a number of sectors, such that the angle of each sector was proportional to the number of individuals of the smoothed population corresponding to each of the equal steps of the independent variable. The disc was then pinned down by its centre on top of a cardboard washer and spun rapidly. While still spinning so fast that the markings were indistinguishable, it was stabbed with a sharp instrument and brought to rest. The value attached to the stabbed sector was then noted.

As to the rate of sampling, once the disc is made up, at least 500 samples can be taken in this way per hour per person, using the left hand for spinning and stabbing.

CHAS. E. R. BRUCE.
W. BEVAN WHITNEY.

The British Electrical and Allied Industries
Research Association,
36 and 38 Kingsway, London, W.C.2.
May 12.

The Occurrence of Indium in Tin.

MR. M. W. GARRETT has recently reported the general occurrence of traces of indium in tin (NATURE, Feb. 12, 1927, p. 260). I wish to confirm this observation, which was also made here last January in the course of some other work.

Indium was then detected spectrographically in three samples of tin, and of a number from varying sources since examined only four were found free from it. These included two specimens containing 98.94 per cent. and 97.60 per cent. tin, probably of Chinese origin, the leady 'RBW' brand from electrolytic detinning of tinplate scrap, and the extremely pure 'Chempur' brand (99.998+ per cent. tin). All 'English' brands tested showed strong traces of indium.

Several varieties of soft solder gave a positive result also, and in both tin and solder the most persistent line was found to be $\lambda = 4102$, the next in persistency being $\lambda = 4511$, in agreement with Garrett's result in the case of tin, and contrary, as he has remarked, to de Gramont's.

Indium does not appear to be recognised at all as an impurity in tin. The almost complete neglect of spectral methods of analysis by metallurgists and others may explain this, as the line at 4511 is close to the strong tin line at 4525, and can scarcely fail to be noticed if present.

J. R. GREEN.

The Laboratory,
Batchelor, Robinson and Co., Ltd.,
Nevill's Dock, Llanelli,
May 13.

Sand-flies and Kala-azar.

IN the issue of NATURE dated Mar. 26, p. 460, there is a letter from the Kala-azar Commission of the Royal Society working in north China in which the claim is made that for the first time an infection with kala-azar has been produced by means of the intra-peritoneal inoculation of the midgut contents of the genus *Phlebotomus* into an experimental animal.

As the letter is dated Jan. 28 the mistake is a natural one, since the writers cannot then have seen the report of a similar and earlier experimental success on the same lines obtained by the Indian Kala-azar Commission in Assam. The report of this experiment,

in which a white mouse was infected with kala-azar by the intra-peritoneal inoculation of the alimentary canal contents of *P. argentipes* infected by feeding on kala-azar cases, was published in the Jan. 1927 number of the *Indian Journal of Medical Research*, but was actually received for publication on Sept. 6, 1926. The fact that the workers in China were working with *P. sergenti* var. and the hamster *Cricetulus griseus*, while the Indian Commission was working with *P. argentipes* and the white mouse, does not affect the question of priority at issue.

H. E. SHORT.
(Director.)

Kala-azar Commission,
Shillong, Assam, India,
May 14.

Early Suggestion as to the Vacuum Flask.

THE following extract from "Mechanical Inventions and Suggestions," by Lewis Gompertz, may interest some readers of NATURE:

"SUGGESTION TO PRODUCE A FIRE-PROOF BOX.

"That this suggestion would succeed, I am far from trusting to, but as possibly it might to some extent do so, it may not be amiss to describe it untried. The box is made of steel, etc., highly polished, as polished metals reflect back the heat as well as the light that are cast upon them. This box is then put into a much larger air-tight case of iron, and has legs of thin wire to prevent it touching the outside case, and all the air is pumped out so as to leave a vacuum between the two boxes, and so that no heat can be conveyed to it by the contact of air; and as the radiant heat is rendered harmless by the polish, and the heat of contact is prevented by the vacuum, it seems that the heat is kept out entirely, excepting through the small wire legs."

The book, which is a second edition, unfortunately bears no printed date, but was given to me in 1856. Lewis Gompertz was secretary to the Animals' Friend Society about 1840.

RICHARD INWARDS.
6 Croftdown Road, London, N.W.5,
May 15.

The Hythe Skulls.

IN a recent number of *Biometrika* (vol. 18, p. 22) Miss Hooke writes that the measurements which I made upon the well-known skulls at Hythe were "made on 590 crania selected from at least double that number." The impression which this gives, and actually has given, is that, out of a large number, half had been selected or chosen for some special reason, and that, therefore, probably they did not fairly represent the whole collection. The skulls were in no way 'selected,' but I had measured all which were available at the time, though more have since been recovered.

Miss Hooke says that she believes that these were skulls of Kentish people, while the whole of my work shows that they were those of brachycephalic immigrants of the Alpine race who had settled in Hythe, probably quite peacefully, in or before the fourteenth century.

The work on the Hythe skulls has been so often quoted by anthropologists that I feel that I must correct what I regard as a serious mis-statement.

F. G. PARSONS.

St. Thomas's Hospital,
London, May 5.

The Beginnings and the Early Spread of Agriculture.¹

By HAROLD J. E. PEAKE.

FOR hundreds of thousands of years, man depended for food and clothing upon the products of the chase. As the last northern ice-cap retreated, Upper Palæolithic man hunted big game on the tundra and cold steppe that lay outside it. Then, as the ice-cap diminished, the zone of open country contracted, and first a coniferous forest, followed by a deciduous forest, occupied the temperate latitudes. Oak forests covered the greater part of these regions in late Magdalenian times, causing big game to become scarce and to retreat to such open lands as were left.

Thus ended the Palæolithic Age. During the Epipalæolithic Age that followed, small isolated communities lived by the shores of the sea, or of lakes and rivers, feeding on birds, fish, and molluscs, supplemented by nuts, berries, and roots. These were hungry times, and it seems likely that some had recourse to collecting wild grass-seeds, as do the natives of Queensland to-day.

Some Epipalæolithic man, or probably one of his woman kind, having collected the seeds of some grass, ancestral to modern grain, must have cast some of these on an open patch of soil and noted that fresh and sturdier plants arose on the spot; a repetition of this process constituted the first advance in agriculture. To ascertain where and when this happened, we must discuss the grains now in use and the places where they occur wild.

The countries in which rice is now grown are known to have received their civilisation from areas long acquainted with the cultivation of wheat and barley. A species of millet, *Panicum colonum*, was used at an early date in Egypt, but it may have been collected from wild plants. *P. miliaceum*, the millet now cultivated, was first grown in south Russia at a much later date. Rye was a common weed in fields of wheat, and in high altitudes supplanted the crop. Oats are a northern crop, and the first evidence of the cultivation of this grain comes from an early Iron Age village in Wiltshire. Barley and wheat have been cultivated from a very early time, though it is not clear which grain was grown first. It is obvious that both must first have been cultivated where they occur wild.

Wild barley is found in south-west Asia; it has been found also in two places in Tripoli. It may once have grown wild along a strip of north Africa from Palestine to the Gulf of Gabes. Wheats are of many species, but may be divided into three groups: einkorns (*T. monococcum*) with 7 chromosomes, emmers (*T. dicoccum*, etc.) with 14, and bread wheats (*T. vulgare*, etc.) with 21. Wild einkorn (*T. ægilopoides*) is found throughout Asia Minor and in Syria; it occurs also in parts of Greece, Bulgaria, and southern Yugoslavia. Wild emmer (*T. dicoccoides*) occurs from Mount Hermon

and the Anti-Lebanon to the mountains of Moab, east of the Dead Sea; a claim has been made for its occurrence farther east, on the borders of Persia. The origin of the bread wheats is uncertain; they are thought to be hybrids, but whether of *T. dicoccoides* and an *Ægilops*, an unknown *Triticum* and an *Ægilops* or *T. dicoccoides* and *T. ægilopoides* is uncertain. At one place only are both emmer and einkorn found growing wild together; this is on the slopes of Mount Hermon, near Damascus, where Aaronsohn found both growing with wild barley.

There is, however, a school of thought which claims that there was corn in Egypt before it was known elsewhere. This school is championed by Prof. Elliot Smith. Since no form of wheat is known to have grown wild in Africa, the claim is made that barley, which, as we have seen, occurs wild near the north coast of that continent, was first cultivated by the banks of the Nile.

Between 1901 and 1903, Mr. Lythgoe, under Dr. Reisner's directions, explored a predynastic cemetery at Naga-ed-Dêr; this is known as cemetery 7000. No account of the contents of these graves has yet been published, but short references to the cemetery occur in "The Early Dynastic Cemeteries of Naga-ed-Dêr" and in "The Archæological Survey of Nubia." From the latter it would appear that Dr. Reisner has divided the predynastic graves which he has found into three categories—early, middle, and late—and that the graves of cemetery 7000 were early and middle predynastic.

Elliot Smith examined the bodies from these graves, and submitted the contents of the stomachs of a number of them to Dr. Netolitzky, who reported in a letter that several of them contained husks of barley. In two papers that he published shortly afterwards he stated that the glumes were either those of wheat or barley, but later he passed on the material to a pupil, Dr. Hedwig Gherazim, who finally proved that the glumes were those of barley. This proves that these predynastic Egyptians ate barley, and presumably cultivated it, but, as Percival has pointed out in NATURE, since the glumes of wheat do not adhere to the grain, they may have eaten that too.

The predynastic period is a long one, and it is important to know to what part of it these graves belong. Though no dates for this period are available, Sir Flinders Petrie has invented an ingenious device for zoning it. This is the system of sequence dates, which is accepted by nearly all Egyptologists except Dr. Reisner. These sequence dates run from 30 to 78, and the period is usually divided into early s.d. 30–39, middle s.d. 40–59, and late s.d. 60–78. It is not clear that these agree exactly with the corresponding divisions of Dr. Reisner.

Now about s.d. 40 there appears a number of objects not met with in earlier graves; notably

¹ Substance of two lectures delivered at the Royal Institution on Mar. 31 and April 7.

pear-shaped mace-heads and wavy-handled pottery. Both of these occur in Palestine, and the former are found in very early deposits in Mesopotamia. The inference is that invaders from Palestine had brought in these new objects; they might also have brought with them the knowledge of wheat and barley.

Dr. Hrozny, quoting Schäfer, states that Legrain and Lampre found barley and emmer in a tomb with a contracted burial at Silsileh, without a trace of copper. I cannot find an account of this grave, for de Morgan, who mentions the cemetery, says nothing of grain. Schulz, however, says that the grain was barley, and not emmer, as had been thought.

At Abydos, Prof. Peet found kilns for drying grain, and in them some carbonised matter from which Prof. Harvey Gibson extracted grains of wheat. In similar kilns near by, Peet found pottery fragments belonging to the middle predynastic period. At Badari, Miss Caton-Thompson found grain, identified by Percival as emmer, in a ruined hut; above this hut was a layer of late middle predynastic pottery. In a grave at Hemamieh, between Qua and Badari, Brunton found grain, also identified by Percival as emmer; the pottery, he tells me, is rough and not very typical, but he places this between s.d. 37 and 44. He adds: "A slate, a disk-shaped mace-head, and a stone vase would all be round about s.d. 40."

The evidence of these three discoveries tends to show that wheat arrived in Egypt in s.d. 40, and was freely used early in the middle predynastic period. Whether barley was grown earlier depends on whether the graves in cemetery 7000 at Nagad-Dêr and that at Silsileh date from before this time. In the absence of details as to the grave contents this must remain for the present an open question.

Thus it would appear that wheat certainly, and perhaps barley too, were first cultivated in Syria, probably on the slopes of Mount Hermon. In this connexion it is well to remember the statement of Diodorus Siculus, written 2000 years ago, that the Egyptian goddess Isis discovered "wheat (*τρυφός*) and barley growing promiscuously about the country along with other plants, and unknown to mankind," and that this occurred at "Nysa, a high mountain in Phœnicia, far away."

As we have seen, emmer was taken to Egypt at the beginning of the middle predynastic period; thence this grain appears to have been carried to the lands surrounding the Mediterranean. Grain was also cultivated early in Mesopotamia, though which grain was known there first is uncertain.

Before 2000 B.C. the Sumerians compiled lists of kings and dynasties, beginning with eight or ten antediluvian monarchs, who ruled at various cities in Mesopotamia. One of these kings reigned at Eridu, while another, who ruled at Suruppak, escaped in a boat from the flood. After the flood there ruled in succession dynasties at Kish, Erech, and Ur. A tablet found near Ur mentions A-annipadda, son of Mesannipadda, the founder of the

first dynasty of that city, and quite lately a lapis lazuli cylinder seal of Nin-Kur-Nin, Mesannipadda's queen, was found in a grave at Ur. No search has yet been made for relics of the first dynasty of Erech, but at Kish, Prof. Langdon has found a layer which he believes dates from the first dynasty of that city, the first after the flood. Here have been found tablets covered with pictographic inscriptions and also some pots of a polychrome ware.

Similar polychrome pottery was found last year at Jemdet Nasr, about 16 miles from Kish, and in one of these pots some grain, which is clearly a kind of wheat. Unfortunately, experts differ as to the species. An American botanist has identified it as *T. vulgare*, Dr. Stapf believes it to be *T. compactum*, a more developed type of *T. vulgare*, while Percival states that it is *T. turgidum*, a more developed type of *T. dicoccum* or emmer. Whatever may be the ultimate verdict, it is clear that wheat of some kind had long been cultivated in Mesopotamia at the time of the first dynasty of Kish.

At Tell el Obeid, however, graves have been found which are believed to antedate the first dynasty of that city by a long time; they contained fine painted pottery. Similar pottery, sickles, hoes, and querns, and pear-shaped mace-heads, have been found at Abu-Shahreïn, the site of Eridu, the seat of one of the antediluvian monarchs. It is clear that grain was grown in Mesopotamia before there took place the disaster which gave rise to the story of the Great Flood.

At a very early date people making highly burnished pottery had been living at Knossos in Crete; their figurines suggest that they came from Asia Minor. No evidence of agriculture has been found among their remains, but if they cultivated grain it is likely to have been einkorn, which is native to Asia Minor. About 3400 B.C. fresh people arrived on the Mesara Plain; these Sir Arthur Evans believes came from the north-western corner of the Delta. Though there is again no evidence of agriculture among the remains found of these people, they can scarcely have been ignorant of the practice, and probably cultivated emmer. It seems likely that it was the Cretans who disseminated this grain throughout the Mediterranean area.

Other people from south-west Asia Minor were working the mineral resources in the Cyclades about the same time, and a few centuries later settled in Argolis and near Corinth. It is thought that these people grew grain, and if so it is likely to have been einkorn. Other people, also from Asia Minor, settled still earlier in Thessaly. These are known to have grown grain, though of what type is uncertain; again it seems likely that it was einkorn. A third set of people, probably from Asia Minor, came apparently by boat to the Middle Danube basin, and settled near the gold and copper deposits of Hungary and Transylvania. It seems likely that they had arrived there some centuries before 3000 B.C. Einkorn has been found in some of their settlements.

Lastly, we have the Black Earth lands of south Russia, in which we have evidence of a civilisation, the first stage of which is thought by most people to be coeval with those mentioned in Thessaly and the Danube basin. This civilisation is distinguished by a profusion of painted pottery, and evidence that the people who made it were grain growers. According to Prof. Childe, this civilisation was destroyed about 2600 B.C., when some of the people fled to Thessaly, inaugurating there the second Thessalian civilisation. The destroyers seem to have been nomads from the steppes east of the Dnieper; these seem to have invaded the Danube basin, founding there the second Danubian civilisation. Now at Sesklo, a second Thessalian site, and at Lengyel, a second Danubian site, grain has been found; in both cases the sample contains both einkorn and *T. vulgare*. The inference is that both regions grew einkorn during the first phase, and that *T. vulgare* was introduced into both from the

Black Earth lands. Quite recently a paper has been published in Kiev, citing the existence of *T. vulgare* from a site near that city, belonging to this culture, though whether this belongs to the first or second phase is uncertain.

At Anau, a village site in Turkestan, painted pottery has been found, bearing some resemblance to that of the Black Earth lands. In the earliest layer on this site were found potsherds containing impressions of grain; this grain has been identified as *T. vulgare*. From this it is suspected that the art of painting pottery and the cultivation of bread wheats both arose somewhere in Transcaucasia.

From Crete and the Danube basin the practice of agriculture spread, by sea and by land, to all parts of Europe, while from Turkestan it was carried, with painted pottery, certainly to north China and most probably also to north-west India.

Television.

By Prof. E. TAYLOR JONES, University of Glasgow.

ON May 24 and 26 I proceeded, at the invitation of Mr. John L. Baird, to the Central Station Hotel, Glasgow, to witness demonstrations of television between London and this city. I was received by Mr. Baird's colleague, Capt. Hutchinson, who explained that the transmission was to take place over the telephone line, Mr. Baird, in his laboratory in London, being in charge of the transmitting apparatus.

The earlier apparatus devised and used by Mr. Baird has been described by him in the *Journal of Scientific Instruments* for Feb. 1927. A model of the original transmitting apparatus is in the possession of the University of Glasgow, of which Mr. Baird is a former student. The following additional information as to the method has been supplied by him:

"The method used in the London-to-Glasgow demonstration consisted in passing an image of the object being transmitted over a light-sensitive cell in a series of strips. The modulated current from the cell was transmitted over the ordinary trunk telephone line, and at the receiving station in Glasgow was used, after amplification, to control the light of a glow discharge lamp, a modified form of neon tube, giving a light of intense brilliance, being employed. By means of a revolving slotted shutter a point of light from this lamp was caused to travel over the field of vision in exact synchronism with the traversal of the image over the cell at the transmitting station, complete traversal taking place in about one-eighth of a second."

The receiving apparatus was set up in a semi-darkened room, the lamp and shutter being enclosed in a case provided with an aperture. The observer looking into the aperture saw at first a vertical band of light in which the luminosity

appeared to travel rapidly sideways, disappearing at one side and then reappearing at the other. When any object having 'contrast' was placed in the light at the sending end, the band broke up into light and dark portions forming a number of 'images' of the object. The impression of sideways movement of the light was then almost entirely lost, and the whole of the image appeared to be formed simultaneously. The image was perfectly steady in position, was remarkably free from distortion, and showed no sign of the 'streakiness' which was, I believe, in evidence in the earlier experiments.

The size of the image was small, not more than about two inches across when the 'object' was a person's face, and it could be seen by only a few people at a time. The image was sufficiently bright to be seen vividly even when the electric light in the room was switched on, and I understand that there is no difficulty in enlarging the image to full size. I was told also that arrangements will soon be made for transmitting larger 'objects,' and for increasing the number of appearances of the image per second.

The amount of light and shade shown in the image was amply sufficient to secure recognisability of the person being 'televised,' and movements of the face or features were clearly seen. At the second demonstration some of those present had the experience of seeing the image of Mr. Baird transmitted from London while conversing with him (over a separate line) by telephone.

My impression after witnessing these demonstrations is that the chief difficulties connected with television have been overcome by Mr. Baird, and that the improvements still to be effected are mainly matters of detail. We shall doubtless all join in wishing Mr. Baird every success in his future experiments.

The Forthcoming Eclipse.

EXCURSIONS AND OTHER RAILWAY ARRANGEMENTS.

London and North Eastern.

THE London and North Eastern Railway (King's Cross Station, London, N.1) is running the following excursions in connexion with the eclipse:

- (a) June 28. King's Cross, dep. 9.50 P.M.
 Peterborough, dep. 11.28 P.M.
 Grantham, dep. 12.7 A.M. (June 29).
 Newark, dep. 12.28 A.M.
 Retford, dep. 12.54 A.M.

arriving at Richmond, Yorkshire, at 3.42 A.M., returning from there at 10.55 A.M., due York, 12.25 P.M., a stop being made to give passengers an opportunity to look round York. The train will leave York at 3.45 P.M., due Retford 4.57 P.M., Newark 5.22 P.M., Grantham 5.43 P.M., Peterborough North 6.20 P.M., and King's Cross 7.55 P.M. Restaurant cars will be provided, and arrangements are being made to serve refreshments to passengers in the train after the eclipse and before the train leaves Richmond, in addition to meals *en route*.

(b) From Marylebone, leaving about 9 P.M., calling at Amersham, Fimmere, Rugby, Leicester, Loughborough, Nottingham, and Sheffield to Richmond, returning on the morning of June 29, with a stop of a few hours at York, arriving at Marylebone in the evening. Buffet cars will be provided to serve light refreshments.

(c) From Colchester about 7.30 P.M., with bookings from Cambridge (via Ely or Bury St. Edmunds), Ipswich, Bury St. Edmunds, Thetford, Ely, March, Spalding, Sleaford, Lincoln, Gainsboro' Lea Road, and Doncaster, returning from Richmond on the morning of June 29, time being allowed for a few hours at York.

London, Midland and Scottish.

Special restaurant excursion trains are announced by the London, Midland and Scottish Railway (Euston Station, London) to Southport, which is on the centre line of totality.

A cheap excursion to Southport will leave Euston at 11.10 P.M. on Tuesday night, June 28, and supper will be served on this train. Passengers

will return by the 8.20 A.M. train from Southport (Chapel Street) on Wednesday, June 29, on which train breakfast will be served.

Another cheap excursion to Southport, with bookings for 2, 5, and 8 days, will leave Euston at 11.12 A.M. on Tuesday, June 28. Luncheon will be served on the outward journey on June 28 and on the return journey on June 29.

Excursion bookings from certain provincial towns are also being given to Southport, Settle, Llandudno, Colwyn Bay, Rhyl, St. Annes, and Blackpool.

In addition, period bookings will be given on Tuesday, June 28, returning on three specified dates, to stations on the North Wales coast from Manchester, Liverpool, and Lancaster and Yorkshire districts generally, also to Carnarvon and Llanberis from Manchester and Liverpool districts and Chester. Similar bookings will also be given to Southport—Blackpool from stations in Lancashire and Yorkshire.

A special train for the Institution of Civil Engineers is leaving St. Pancras for Settle on June 28, and one for a Stowe Public School party is leaving Buckingham for Rhyl on the same evening.

Great Western.

The Great Western Railway (Paddington, London) announces that a liberal programme of day and period excursion bookings has been arranged to Criccieth and other North Wales resorts for the eclipse from principal stations on its system.

A special train will leave Paddington Station on Tuesday evening, June 28, by which cheap bookings will be given from London, Reading, Oxford, and other principal stations on the G.W.R. route to the north. Day trips will also be run from Cardiff, Bristol, Gloucester, Cheltenham, Worcester, etc., and from the Wrexham District.

Period excursions will also be run from the west of England on Monday night, June 27, and from other principal G.W.R. stations on June 28, enabling passengers to return on June 29, July 2, or July 4.

Obituary.

WE record with regret the death of Prof. John Bagnell Bury, Regius professor of modern history at Cambridge, which took place at Rome on June 1. Born in County Monaghan on Oct. 16, 1861, he entered Trinity College, Dublin, as a sizar, and was elected to a fellowship in 1885. After his election he began to specialise as a historian, publishing his "History of the Later Roman Empire from Arcadius to Irene" in 1889. In 1893 he was appointed professor of modern history in the University of Dublin, and in 1902 he succeeded Lord Acton as Regius professor at Cambridge. He had already published his most important and lasting work, in his "History of

the Roman Empire from its Foundation to the Death of Marcus Aurelius" (Murray's "Student's Histories," 1893), the "History of Greece to the Death of Alexander" (1900), and his edition of Gibbon (1896-1900). In these, his remarkably wide range of knowledge, his extensive acquaintance with languages, his ability to marshal a vast array of facts, and his scientific conception of history, were utilised to the full in a treatment of historical matters which combined a broad grasp of the trend of events with a scrupulous care for detail. In addition to his other published work, he was responsible for the plan of the Cambridge "Medieval History," and collaborated in the editorship of the Cambridge "Ancient History."

News and Views.

How experimental research carried out on dogs has benefited both that animal and man is described in the Memorandum of the Medical Research Council on the Dogs Protection Bill now before Parliament. Recent advances in knowledge have been made by this means in the study of rickets, disorders of the teeth, diseases of the heart and circulation, and in diabetes, as well as in distemper and various types of jaundice prevalent among dogs. The proof that rickets is a dietary disease and can be cured by changing the diet, so as to supply an adequate amount of the anti-rachitic vitamin, was first obtained by feeding experiments carried out on puppies. An unexpected outcome of these experiments was the discovery that absence or deficiency of this vitamin in the diet prevents the proper development of the hard enamel of the teeth: this work is still in progress, and may lead to the prevention of dental decay in human beings. The control of diabetes by the use of insulin, which has been such a boon to sufferers from this disease, was made possible by experiments on dogs: in fact the whole of our knowledge of this disease from the time of the discovery of the relation of the pancreas to diabetes to the discovery of insulin has been gained by experiments on this animal. Nor must the benefits to the dog itself from experimental research be forgotten: protection against distemper is already becoming practicable, as also against the spirochætal jaundice which is not uncommon in Great Britain and often fatal, whilst a cure has been found for the malignant jaundice or piroplasmosis of dogs in the injection of the dye trypan blue.

It is the considered and unanimous judgment of the Medical Research Council that the proposals of the Dogs Protection Bill would place an insuperable and permanent barrier across some of the chief paths of progress in medical research. The memorandum describes the reasons which make the use of dogs for experimental purposes necessary, and gives in some detail results which have been, or are being, obtained from such experiments. Considerations of size are frequently important: practicable alternatives to the dog are the sheep, pig, goat, or ape, but none can be kept completely healthy and comfortable in the laboratory except the dog. Moreover, its long domestication has assimilated its natural diet to that of man, and many of its bodily structures provide the nearest approximation among animals to those of man, so that results of experiments, both dietary and pharmacological, can often be applied directly to the case of human beings. The special habituation of the dog to man's presence is also in favour of its use, since it is less terrified by the near approach of human beings than other less domesticated animals. On the other hand, the memorandum points out that the dog is only used when no other smaller animal is available, and only a very small minority of experiments are performed with it. The knowledge which has been gained from such experiments forms part of the everyday armamentarium of the physician or surgeon, and

includes the foundations of the physiology of the digestive and circulatory systems. To avoid the danger of the use of stolen dogs for purposes of experiment, the Council recommends that the Dogs Act, 1906, be amended to allow of the use of some of the 50,000 animals annually destroyed in London alone. These dogs are those which either have no owner or whose owners do not care enough about them to make inquiries when they are lost. It would allow part at least of the now useless annual massacre of dogs to be turned to the permanent advantage of mankind and of other animals.

THE forthcoming total eclipse of the sun affords radio amateurs an excellent opportunity of experimenting on the effects produced by the eclipse in preventing the sun's rays passing through part of the conducting layer in the upper atmosphere. The shadow cast by the moon will pass through the reflecting surface of this layer at approximately 100 miles south-east of the path of the visible eclipse. During the eclipse, the layers over a broad band of the country between Cardiff and Grimsby will be a band of totality for radio observations. In the *Wireless World* for June 8, Prof. E. V. Appleton gives a popular description of the phenomena that are likely to happen, and offers useful advice to all who desire to attempt to record them. Observations, he says, ought to be confined to the broadcasting range or even to waves of shorter wave-length. These will probably give indications of the phenomena associated with sunrise and sunset after the normal sunrise has taken place. The observations made on the day of the eclipse will, however, be of little value unless they can be compared with the results normally obtained. Hence observations of a similar character should be made at least on the morning before, and on the morning after the day on which the eclipse occurs. Observers should choose a station the signals from which they can receive with great ease, and make a special study of the sunrise and sunset characteristics of these signals. They will, therefore, only have to note if any extra phenomena are observed on the morning of the eclipse. It is important to time each observation correctly with a watch or clock checked before and after the series of observations by means of time signals. It should also be recorded whether the times given are in British summer time or Greenwich mean time.

THE Halley Lecture on "Modern Eclipse Problems," delivered by Mr. F. J. M. Stratton on May 20 and just published by the Clarendon Press, Oxford, at 2s. 6d. net, provides a comprehensive and clear account of investigations, carried out and contemplated, into the nature of coronal light and related matters. Chief attention is rightly devoted to these subjects, because it is only during the brief period of a total eclipse that the corona can be studied spectroscopically or its form be portrayed. As Mr. Stratton remarks, "The question of the source of the coronal light, particularly in the lower levels, remains a very open one, and

further detailed work must be done, combining spectroscopic, photometric, and polariscopic methods, before a final answer can be obtained." The characteristic bright-line spectrum of the corona has not yet been reproduced in the laboratory, so that although a fair amount is known as to coronal lines and their relation to the chromosphere, some very fundamental questions still remain unanswered, and while it is only possible to study them for less than two minutes a year on an average, they are likely to remain so. All students of physical science will find Mr. Stratton's lecture full of interest, and his notes on the forthcoming eclipse on June 29 afford much valuable guidance to lay readers as well. We are glad that the lecture is available in time to be mentioned in this week's issue of *NATURE* and are sure that it will find many appreciative readers.

THE announcement that Sir Daniel Hall has ceased to hold the post of Director of the Intelligence Division of the Ministry of Agriculture will cause general regret on the part of agriculturists and many others. It is true that he retains the post of Scientific Adviser to the Ministry, and that, consequently, no immediate change in policy affecting agricultural research need be feared, but the need of scientific direction in the lower walk of education will always remain, and it is not clear how far the spirit of science will be permitted to inform the future administration of the Department. But Sir Daniel Hall's influence in the past has extended far beyond strictly scientific issues. It is no exaggeration to say that he has displayed a remarkable capacity for handling the difficult border-land problems that lie between technical husbandry and public policy. With no intention of commending the arts of the demagogue, we must admit that, in these days, the influence of the finished public speaker is very great, and that influence Sir Daniel Hall has exercised in a very marked degree. In a narrower field also, that of the committee of experts, this spiritual gift—if we may be permitted the epithet—has been equally marked, as many a doughty opponent, to his chagrin, has experienced. But we particularly cherish the recollection of an address delivered to a body of American students some years ago, which well illustrates Sir Daniel's many-sided gifts. His address—with delightful irony if we note the environment—deprecated the relentless pursuit of efficiency, and recalled with regret the conversion of a certain meadow "starred with Grass of Parnassus ('where, too, the sedgewarbler swung her nest') into a pond for the growth of food—to wit, watercress to grace the Cockney's tea-table."

WE are glad that the B.B.C. has decided to adopt the principle of stating the kilocycle figures instead of the wave-length figures in connexion with all its stations. The reason that has frequently been urged against giving the frequency instead of the wave-length is that the large figures involved might easily lead to mistakes. For broadcasting, however, this would not apply. The wave-length of the waves broadcast from Aberdeen, for example, is 500 metres

and the number of kilocycles per second is 600. The Union Internationale de Radiophonie, Geneva, has based its system of measurement on kilocycles (1000 cycles) and not on wave-lengths. The minimum spacing between a wave exclusive to a single station and a common wave used by several stations has been fixed at 10 kilocycles. When this is done the heterodyne note has a frequency of 10,000 vibrations per second, and so, even to one whose hearing is acute, it is barely audible. With the new arrangement all the kilocycle measurements are in round numbers. It is easier to remember that Daventry is 187 kilocycles per second than that it has a wave-length of 1604.3 metres. The London station has a frequency of 830 kilocycles and a wave-length of 361.4 m. In the future it will be designated by the former number.

AMONG the six ingenious inventors, Kay, Paul, Hargreaves, Arkwright, Crompton, and Cartwright, whose work laid the foundation of the great textile industry of Lancashire and ushered in the Industrial Revolution, Crompton is famous for his invention of the spinning-mule, a machine embodying some of the principles of the drawing rollers of Paul and Arkwright with the stretching contrivance of Hargreaves' jenny, which solved the problem of spinning fine yarns. Crompton was born on Dec. 3, 1753, and died at 15 King Street, Bolton, on June 26, 1827, and Bolton during Whitsun week has just been worthily commemorating the centenary of his death. The celebrations included an official visit of the Mayor and Corporation to the Swedenborgian Church of which Crompton was long organist and choirmaster, an exhibition at the Chadwick Museum, a pageant, a civic procession to Crompton's tomb and monument, and meetings of the Textile Institute at which papers were read referring to Crompton's work. Among these was a historical review by Mr. H. W. Dickinson, who represented the Newcomen Society; an account of the state of the cotton trade during its early development, by Mr. Frank Nasmith; and a paper by Mr. W. Scott Taggart dealing with the significance of Crompton's invention and subsequent developments. Like many of his fellows, Crompton, partly due to his shy and reserved character, failed to reap the full benefit of his invention. He was, it is true, given a Parliamentary grant of £5000, but he died in comparative poverty and obscurity, leaving furniture which was valued at £17.

DURING this summer the new diocese of Derby will be inaugurated, and All Saints' Church, Derby, will become the Cathedral Church. It is in the Cavendish vault in this church that Henry Cavendish is buried, and as there is no memorial to him it has been proposed that steps should now be taken to erect one. Cavendish was born in 1731 and died in 1810, and practically all his life was devoted to experimental science. His investigation of the properties of hydrogen and discovery of the composition of water, his famous experiment on the mean density of the earth, and his electrical investigations, have rendered his name immortal.

For nearly fifty years he was a fellow of the Royal Society. Some of his experiments were probably made in his father's stables in Great Marlborough Street, but the greater part of his life was passed in his bachelor home which faced Clapham Common. Though gifted with great acuteness of mind and sound judgment, and with a passion for accuracy equal to that of an Airy or a Rayleigh, he was morbidly shy and reserved and his life was almost that of a recluse. So shy was he, that no portrait of him was ever taken, and the only sketch we have was made surreptitiously. Brougham declared that Cavendish probably uttered fewer words than any one, outside a Trappist monastery, who lived to nearly four-score years. A contemporary of Watt, Black, and Priestley, Cavendish was the most distinguished natural philosopher Great Britain could claim, and he was recognised as such by other nations. Biot wrote of him as "le plus riche de tous les savants, et probablement aussi le plus savant de tous les riches." There are reasons for believing that a memorial tablet to Cavendish once existed in the church in which he lies, and it may have been removed when the church was restored about fifty years ago. In any event, the proposal now put forward is one which should meet with the support of all the various scientific societies whose work is included in the great domain of physical science and its application.

THE History of Science Society, which has its headquarters in the United States but is well known in Great Britain through its journal *Isis*, is following up the Newton celebration of last March at Grantham by a similar gathering at the Columbia University in New York on Nov. 25 and 26. The programme is full and varied. Mathematical, astronomical, and physical papers are to be followed by others which deal with matters only alluded to incidentally, if at all, at the English meetings. Thus there will be a full account of Newton's "Theological Thoughts" and his "Mint Problems," and an equally long paper on Newton's "First Disciple in America." We shall look forward with interest to this, for his name is not familiar to the ordinary Newtonian in England. There is also to be an exhibition of Newtonia, including the first edition of the "Principia," with portraits, medals, and autograph letters, of which very likely the United States may possess a larger store than we have in England. Any one who has such material and would be willing to lend it, should communicate with the secretary of the History of Science Society, Frederick E. Brasch, at the Library of Congress, Washington, D.C. The Programme Committee includes some of the best-known names in American mathematics, astronomy, and physics, and we wish the celebration every success.

DR. JOSEPH S. AMES, of Baltimore, has been elected chairman of the U.S. National Advisory Committee for Aeronautics in succession to the late Dr. Charles D. Walcott, who died on Feb. 9 last. Dr. Ames is one of the original twelve members of the Committee appointed in 1915. He was born in Manchester,

Vermont, in 1864, and worked at the Johns Hopkins University, from which he received his doctorate in 1890. After studying abroad, he went as assistant professor of physics to Johns Hopkins University and has been professor of physics there since 1890. In 1909 he was elected a member of the National Academy of Sciences for "outstanding work in physics," and was one of the first members of the National Research Council organised by the Academy in 1917. He is the author of many articles and books on physics, electricity, and mathematics. For the past eight years, Dr. Ames has been chairman of the Committee on Aerodynamics of the U.S. National Advisory Committee for Aeronautics, and as such has directed the preparation of research programmes for the air services of the U.S. Army and Navy, the Langley Memorial Aeronautical Laboratory, and the Bureau of Standards, and has effected a practical co-ordination of effort among the government and private agencies concerned with the scientific study of various aspects of the fundamental problems of flight.

THE report of the chairman of the National Illumination Committee for the year 1926 mentions that the proposed plenary session of the International Illumination Commission in New York has been provisionally postponed to 1928. In the meantime, meetings of the executive and technical committees are to take place in Rome in September this year. It is also stated that Belgium, Germany, and Japan have been added to the list of countries represented on the International Illumination Commission. In a supplementary report an account is given of the work of the committees operating under the British Engineering Standards Association. Five British standard specifications have been issued, or are on the point of completion, namely, those dealing with portable photometers, the British standard glossary of terms used in illumination and photometry, industrial reflectors for direct general lighting, illuminating fittings of translucent glassware for interior lighting, and street lighting. The question of neck dimensions of illumination glassware is now being considered, and the work on industrial reflectors is based mainly on the specification of a suitable 'cut-off angle' so as to diminish glare. The work of both these committees has been rendered difficult by the wide tolerances allowed on the light-centre-length of electric lamps, and it is hoped to set up standards for all types of lamps, or at least for pear-shaped and spherical lamps. Reference is also made to a method of defining glare which has been embodied in the specification on street lighting.

THE publications of the Science Museum, South Kensington, are most useful to inventors and to students of the development of various branches of manufacturing industry. We can commend the catalogue of the electrical engineering section recently published (London: H.M. Stationery Office, 1927. 1s. 6d. net). The descriptive and historical notes are well done, and the numerous illustrations almost dispense with the necessity of making a visit to the

museum. It proves the leading part taken by the pioneers of Great Britain in the development of the industry. In many cases the apparatus appears crude, but it generally shows the principle which the inventor more or less successfully endeavoured to apply in practice. From this point of view we think that replicas of the original apparatus, when the latter is not available, are most useful, and we think that the number of them might advantageously be increased. Faraday was the first and the greatest of the pioneers, but he was closely followed by Kelvin, Parsons, and Ferranti. Many of the exhibits have figured in famous law cases. Some of the apparatus was invented for special purposes and is no longer required. Some of the machines are still being manufactured with practically no change in their appearance or design, but others have been developed almost beyond recognition. We doubt whether high-tension direct current will ever develop in England. The transverter has still to prove its usefulness. The 230 kilovolt lines in California, mentioned by the writer of the 'notes,' will be eclipsed by the 380 kilovolt line being constructed in Germany. 'Copper-clad steel' for transmission lines is not now so popular as aluminium wires with a steel core. With this conductor spans of so much as 1000 feet are used in South Wales.

THE National Broadcasting Company of America has made good progress since it started six months ago. Its objects are to provide a high-class programme which will be within easy reach of every inhabitant of the United States. Its position to other broadcasting companies is analogous to that of the Associated Press to the local newspapers in Great Britain. It is noteworthy that it is paid for by indirect advertising. The American advertiser broadcasts what is called a 'sponsored' programme. His name is only heard in an unobtrusive way in connexion with the announcement of an item of the programme. An interesting account of the company's activities by A. Dinsdale appears in the *Wireless World* for May 11. More than a hundred broadcasting stations have applied for the N.B.C. service. Their lines radiate from New York to the Canadian border, to the Pacific coast, and to Florida and Texas. Special telephone circuits with special valve repeaters are used to carry the programmes to the various stations. On Feb. 22, 42 stations broadcast President Coolidge's address. It is estimated that 25 million people heard him. It was also transmitted by a beam wave and broadcast by the B.B.C. in England. In broadcasting *Faust* from the Chicago Civic Opera House, no less than 15 microphones in parallel were used. Two microphones were hung up high over the audience so as to produce an 'echo' effect, the sounds reaching them a fraction of a second later than they did the seven footlights microphones. The N.B.C. is not seeking a monopoly of broadcasting, and welcomes new local broadcasting stations. It is also hoped that considerable use will be made of its facilities, for educational purposes. A 'university in the air' well endowed by philanthropists is one of its ideals.

THE divergent views held by the Cambridge and Vienna schools on the question of disintegration of atomic nuclei by α -particles have again been brought into prominence with the publication by the latter of a group of papers in the *Zeitschrift für Physik* of May 5. It is still maintained that the conditions employed in the Cavendish Laboratory are such that a large number of scintillations due to H-particles of short range are missed, and, in particular, that with the special Hilger microscope used by Dr. Chadwick, the intensity of the flashes is limited because the pencil that emerges from the eye-piece more than fills the pupil of the observer. The validity of the Geiger test for efficiency of observation is also disputed, on the ground that when two persons count a group of particles of variable speed simultaneously, both will tend to miss the weaker scintillations. If the conclusions of Dr. Pettersson and his collaborators are to be accepted, the nuclei of almost all elements so far examined can be broken up, and the disruption can be accomplished by α -particles of small speed, with the production of protons the velocity of which has no marked lower limit. All of these results are in sharp disagreement with the experiments of Sir E. Rutherford and Dr. Chadwick. Carbon, for which the latter workers found no evidence of disintegration, and aluminium have been carefully re-examined, and the earlier Austrian results have apparently been confirmed by use of a photographic method, and with the Wilson expansion apparatus. Dr. Stetter has also succeeded in applying a modified form of the Aston mass-spectrograph to the problem, and has shown that protons are present in about the numbers found in the scintillation experiments, and with about the same velocities. The opinion of the Austrian workers is that whilst counting of scintillations does not always lead to accurate quantitative determinations, they can nevertheless usually distinguish between the flashes produced by α -particles and by H-particles, and that the results which they have obtained in this way are adequately confirmed by other methods.

REGIONALISM in some form or other has made rapid strides during recent years. Towns and districts with a local consciousness are taking stock of themselves in an endeavour to see what manner of region they are at present and what they will or may become. The latest aspirant to self-examination is south-west England. Its sponsor is the University College of South-West England, situate at Exeter. This region, it is claimed, is "a distinct natural unit with a long tradition of human settlement rooted in native soil and with a continuous cultural history little disturbed by the violent innovation of industrial activity." The survey aims at a detailed investigation of social life "viewed as the interaction of Place, People, and Work or Function." Under this comprehensive scheme everything within south-west England from boglands to betting, and from social stratification to the stratification of the rocks, comes under review. Now the collection of exact data, whether geological, anthropological, or social, for any locality is eminently desirable. Too often the recording of the present has

been forgotten in the admiration of the past or the aspiration for the future. It is desirable, also, that regional data shall be housed in some recognised centre for reference and possible collation for various purposes. To this extent the new survey is to be commended for the work it is about to undertake. The accumulated data will furnish raw material for innumerable workers and will provide a datum line to which subsequent investigations may be referred. There is a danger, however, that the survey may go beyond the scientific collection of data to a pseudo-scientific philosophy. To state that "racial or temperamental traits may be the result of climatic conditions and may in turn have some part in determining the religious outlook" is doubtful wisdom. The survey may well rest content if it can adequately observe and record all the data enumerated in its programme without speculating on doubtful relationships among various groups of data.

PENDING the publication of the report of the Board of Education's Committee on the public library service in Great Britain, which is expected shortly, the Carnegie United Kingdom Trust, according to the annual report for 1926, has for the most part been content to develop upon traditional lines. The most notable new departure is the policy of offering assistance in book purchase to the smaller-sized libraries on condition of their imposing a higher library rate. This, no doubt, is a step in the right direction in the case of growing towns, in which expenditure on book purchase is often pitifully low. We think, however, that the Trust should have differentiated between towns with stationary and growing populations. Town Councils are proverbially short-sighted in their willingness to accept cash gifts without adequate consideration of the liabilities attached thereto. When the period over which the Trust's gifts carry has passed away, the town may find itself saddled with higher official salaries, a larger stock of books to maintain, and little surplus income to meet the increased liabilities. We think also that the Trust would have been well advised if in making these grants it had stressed the importance of building up strong reference libraries. The tendency of the town's library is always in the direction of increasing its fiction department. Satisfactory progress is recorded in respect of the growth of the Central Library for Students and the 'outlier' library policy of the Trust, and we note with pleasure the rapid development of the work of the National Institute of Industrial Psychology. The fees received by the Institute increased from £6700 in 1925 to £8600 in 1926. The value of its system of vocational tests is now beginning to be recognised both in Great Britain and in the United States.

THE Malthusian League will celebrate its fiftieth anniversary by a dinner, on July 26, at the Holborn Restaurant, London. Among the speakers will be Mr. J. M. Keynes, Mr. H. G. Wells, and Mrs. Annie Besant, who was the first secretary of the League.

PROF. F. G. DONNAN, professor of general chemistry in the University of London, has been elected a No. 3007, Vol. 119]

member of the Royal Academy of Sciences of Amsterdam, thus filling the vacancy caused by the death of Prof. C. Golgi, of Pavia.

THE Makdougall-Brisbane Prize for the period 1924-1926 has been awarded by the council of the Royal Society of Edinburgh to Dr. C. M. Wenyon, for his distinguished work in protozoology. He will deliver an address to the Society at the annual statutory meeting to be held on Oct. 24, when the prize will be presented. The James Scott Prize for the period 1922-1926 "for a lecture or essay on the fundamental concepts of Natural Philosophy," has been awarded by the council to Sir Joseph Larmor, who will deliver a lecture to the Society on July 4. The prize will be presented on that date.

IN an address delivered at a meeting of the Psychological Society at Oxford, Sir Oliver Lodge stated that he considered it as not improbable that the synthesis of organic substances may eventually reach a point at which the production of protoplasm will become possible. The exhibition of vitality may follow. It is certain, he said, that living organisms appeared at some period on the earth, which was once a mass of molten material or even of incandescent gas; and what has happened before may happen again. The production and control of living substance may possibly come within the power of human agency.

"HEALTH WEEK" will be celebrated in Great Britain this year on Oct. 2-8. The object of Health Week is to focus public attention for one week in the year on matters of health, and to arouse that personal responsibility for health without which all public work, whether by the Government or local authorities, must fall far short of its aims. It is suggested that the dominant idea should be "Self help in Health." The movement known as Health Week was instituted in 1912, their Majesties the King and Queen are patrons, and the Royal Sanitary Institute undertakes the central organisation, but local celebrations in each centre are organised and controlled by local committees. A circular may be obtained from the Secretary, Mr. E. White Wallis, 90 Buckingham Palace Road, London, S.W., giving information of the aims and procedure and formation of local committees, with suggestions regarding items for the programme and subjects for lectures.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A full-time lecturer in electrical engineering in the Newport, Mon., Technical College and Institute—The Secretary and Executive Officer, Education Offices, Charles Street, Newport, Mon. (June 24). A metallurgical assistant, Grade II., in the Ordnance Factories—The Chief Superintendent of Ordnance Factories, Royal Arsenal, Woolwich, S.E.18 (June 24). An assistant lecturer in pharmaceutical chemistry at the Cardiff Technical College—The Principal, Technical College, Cardiff (June 25). An assistant for cancer research in the Bland-Sutton Institute of Pathology of the Middlesex Hospital Medical School—The Secretary, Cancer and General Research Committee, Middlesex

Hospital, W.1 (June 30). An assistant librarian (male) for the University of Aberdeen—The Secretary, The University, Aberdeen (June 30). An assistant lecturer in philosophy in the University of Birmingham—The Secretary, The University, Birmingham (July 1). A laboratory steward and lecture assistant in, respectively, physics and chemistry in the Durham Division of the University of Durham—The Head of the Department of Science, University of Durham, South Road, Durham (July 2). A medically qualified demonstrator in the physiology department of the Middlesex Hospital Medical School—The School Secretary, Middlesex Hospital Medical School, W.1 (July 7). A teacher of

engineering subjects at the Gloucester Technical College—The Principal, Technical College, Gloucester. An assistant bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum—The Controller, Sudan Government, London Office, Wellington House, Buckingham Gate, S.W.1. A laboratory assistant under the Sudan Government—The Controller, Sudan Government, London Office, Wellington House, Buckingham Gate, S.W.1. A temporary junior assistant under the directorate of Metallurgical Research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

TIME SIGNALS FOR THE ECLIPSE.—Very ample arrangements have been made by the Astronomer Royal, in conjunction with Mr. Hope Jones and Mr. P. H. Hepburn, and with the kind co-operation of the B.B.C., for transmitting time signals on the morning of the eclipse. The 6-dot signals will be sent at 5^h 0^m, 5^h 15^m, 5^h 20^m, and 5^h 30^m U.T. The sixth is the exact minute. Also every second, except 29^s and 59^s of each minute, from 5^h 22^m to 5^h 26^m U.T., which covers the whole period of totality in Great Britain (Summer Time 1 hour greater than above). The minutes and every fifth second will be named verbally. The signals will be transmitted from Daventry (wave-length, 1600 metres), and we understand from London also. A full rehearsal of the programme was given on Saturday, June 11. Probably no previous eclipse has had such facilities for accurate time determination.

NEW COMET.—The sixth cometary discovery of the year has been made by Mr. Gale at Sydney. There are two previous comets in the catalogue, 1894 II. and 1912 II., discovered by Mr. W. F. Gale. As no initials are given in the present case, there is a doubt whether this discovery is due to him or to his son, Mr. A. W. W. Gale. The following two positions have come to hand.

U.T.	R.A.	S. Decl.	Mag.	Observer.
June 7 604	21 ^h 38 ^m 0 ^s	31° 38'	8.0	Gale, Sydney.
10-137	21 53 4	31 38	10.0	Gonnessiat, Algiers.

The deduced daily motion is +5^m 57^s, 0'. Not much stress can be laid on the decline in magnitude, as there is considerable personality in estimating this for comets. The comet is on the meridian at 3^h 30^m U.T., but is too far south for convenient observation in England. Its designation is 1927f. Of the six discoveries this year, four are new comets and two are the returns of periodic ones.

A LARGE SUNSPOT.—The large group of sunspots described in NATURE for May 21, p. 759, has made its appearance for the second time, being seen in transit across the sun's disc on June 1-15. When near the sun's east limb, there was a large spot followed closely by a smaller composite one. The latter spot was the nucleus of a growing train, which together with the original leader spot finally stretched across 10° of solar longitude, or about 70,000 miles, and had a total area of nearly 2000 millions of square miles. Latterly the group was decreasing perceptibly. It may be remarked that no magnetic disturbance was registered by the magnetographs about the time of the central meridian passage of the group on June 8. It is also of interest that at the time of the forthcoming total solar eclipse on

June 29, the tail-end of this group of spots, if still existent, will be at the sun's east limb at position angle 70°, measured from the north point of the disc. A solar prominence or any peculiarity in the sun's corona should be looked for in this region. Other details of this naked-eye spot—the largest seen as yet this year—are as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Maximum Area.
	June 1-15	June 8.0	16° N.	1/650 of hemisphere

THE NUMBER OF THE STARS.—The Scientific News Service of the Smithsonian Institution, Washington, for May 22, contains an interesting article by Dr. C. G. Abbot on the total number of stars in our system, which he takes as thirty thousand millions, or, as he calls it, 'thirty billions.' (This diversity of use between England and America as to the meaning of 'billion,' 'trillion,' etc., is a perpetual source of confusion, and a decision on the subject by the International Astronomical Union is much to be desired.)

The estimate is derived from star counts down to different limiting magnitudes on photographs of the Kapteyn selected areas. The ratio of increase in numbers for an increase of a unit in the limiting magnitude is found to tend to zero as the stars grow fainter. Assuming that the law continues for still fainter stars, the total number of stars can be arrived at, and is found to be 30,000,000,000.

Earlier investigations of the same kind were made by Chapman and Melotte from the Franklin Adams plates, and by P. J. van Rhijn. The former found the number of stars down to mag. 16.0 to be 33 millions, and by extrapolation similar to that of Dr. Abbot, found the total number in our system to be 3 or 4 thousand millions, which is only $\frac{1}{10}$ or $\frac{1}{5}$ of Dr. Abbot's result. But his is based on photographs showing much fainter stars than the other, so is more trustworthy.

Incidentally, Dr. Abbot gives a fallacious proof that the total number of stars is not infinite: for he says the whole heavens would then blaze like the sun. This is correct only for uniform distribution of stars throughout all space. There is an infinite number of ways in which we could arrange an infinite number of stars, without making the heavens more luminous than they are at present, even granting the perfect transparency of space. We would not contend that the number of stars is infinite, but it is desirable to avoid misleading statements in these articles. Dr. Abbot's estimate of the size of our stellar system is 100,000 light years in its maximum diameter, and 20,000 light years in its minimum one. The article goes on to give some details of stellar physics, including Eddington's recent researches.

Research Items.

ARROW-RELEASE.—Mr. A. L. Kroeber has worked over the material relating to methods of arrow-release, with special reference to the distribution of the various types and its bearing upon the problems of diffusion. His results are published as No. 4 of vol. 23 of the *University of California Publications in American Archaeology and Ethnology*. Five methods of release are recognised: two, the primary and secondary, depend upon a direct hold on the arrow; the tertiary draws on the string holding the arrow between thumb and index; the Mediterranean draws on the string with the end of the fingers at right angles, holding the arrow between index and middle fingers; and the Mongolian employs a thumb, usually with a ring, to pull the string, this release being closely associated with the composite bow of horn, sinew, and wood. The distribution of the Mongolian release is compact and Asiatic, with an extra-Asiatic occurrence among the Yahi in northern California, here attributed to independent invention. The Mediterranean occurs in three areas—Europe to south-east Asia, with the earliest record in Twelfth Dynasty Egypt, Eskimo (Siberia, Alaska, and Baffinland), and in south California, Arizona, and Sonora. These are construed as separate origins. The distribution of the tertiary release is irregular, occurring in central North America, Central America, and the Congo, with eight cases between India and Melanesia. The secondary is the least wide-spread, being reported, apart from doubtful cases, only from North America. The primary is the most irregular, and appears to be due to the persistence of originally 'primitive' or simple methods, and occurs in a distribution marginal to the tertiary release. The general conclusion is that there is a seemingly limited number of normal growth or spread distributions and several probabilities of independent origins.

ORIGIN OF THE CRIMEAN FLORA.—The Russian botanist Wulf has published recently (in the *Mem. Crimean Society of Natural History*, vol. 9, 1926) an interesting paper in which the problem of the origin of the flora of the Crimea is discussed on the basis of some new botanical evidence as well as of the geological data. The main conclusion is that the Crimea represents a fragment of a mountainous 'Pontic continent,' which was a continuation of the northern Asia Minor and existed to the end of the Pliocene, if not in the Quaternary period. The original flora of the Crimea was, accordingly, that of the eastern Mediterranean type, and relics of that flora are still numerous in the Crimea. During its history the Pontic continent had been connected temporarily with other neighbouring lands—with southern Russia, with Dobrudzha, with the region of the Azov sea. At the end of the Tertiary and early in the Quaternary Age the eastern regions of the Mediterranean countries sunk, the Black Sea depression was formed, and the Crimea became a peninsula. During the Ice Age the flora of the Crimea became considerably poorer. Endemic element in the Crimean flora is of two kinds: ancient relics, only 13 in number (*Cerastium biebersteini*, *Eremurus tauricus*, *Centaurea comperiana*, and others), and a large number of young endemic forms (sub-species), which testify to the insular character of the flora. Population of the Crimea by plants, as an analysis of the flora shows, occurred from various sources: from Asia Minor, from western Transcaucasia, from the Balkanian peninsula, and from southern Russia. Prof. L. Berg, who is a well-known Russian ichthyologist, in giving a review of Wulf's paper in *Priroda* (1927, No. 3), says that the

evidence offered by the study of the fresh-water fishes of Crimea does not contradict the suggestion of the former existence of the Pontic continent; this fauna is somewhat poor, including about fifteen species altogether, and the only endemic form is *Barbus tauricus*, which is merely a geographical sub-species of *B. escherichi* distributed in the rivers of Asia Minor flowing into Black Sea.

GRAPHIC COMPARISON OF RELATIVE VARIABILITY.—Prof. Raymond Pearl has devised a simple graphic method for comparing the relative variability of unlike characters belonging to the same or different populations (*Science*, Mar. 11, 1927). The coefficient of variation does not give a clear picture of the scatter in a distribution; but the variation of a population in such diverse features as age, stature, body weight and relative cell volume of the blood can be compared by making two simple transformations of the data: (a) expressing the frequency of each class unit as a percentage of the mean value for each character, and (b) expressing the frequencies as so much per one per cent. of the mean of each character. The values so obtained can be directly plotted on co-ordinate paper and will give superimposed graphs which are directly comparable with each other in all their details. In this way the variability in milk yield of cows may be compared with, for example, the egg production of fowls, and the populations compared may differ widely in number of individuals.

GENETICS AT THE CARNEGIE INSTITUTION OF WASHINGTON.—In the Department of Genetics of the Carnegie Institution of Washington, which has now been in existence twenty-three years, Dr. Banta has now bred parthenogenetic Cladocera for 650 generations, obtaining mutations in reactivity to light, 'excavated head' and intersexes, which show Mendelian behaviour in crossing (Year-Book, 1925-26). It is believed that evidence of the compound nature of the gene is obtained from the multiple allelomorphism in *Drosophila* and also from *Delphinium*. In the fly *Sciara*, Metz finds that in spermatogenesis the chromosomes do not pair, but all the maternal chromosomes pass into the sperm while their paternal homologues are cast off. Consequently the sperm fails to transmit paternal traits. Some genetic confirmation of this has been obtained. In the continuation of genetical and cytological studies of *Datura*, evidence is obtained that non-homologous chromosomes may show mutual attraction, and that pieces of such chromosomes may unite to form whole chromosomes which give aberrant genetic results. In pigeon breeding, strains with high and low thyroid content have been produced, and the action of endocrine glands as a complication in inheritance is emphasised.

LAMBSIEKTE IN CATTLE IN SOUTH AFRICA.—This disease is characterised by weakness and paralysis, chiefly of the locomotor system, and causes considerable mortality and loss. Sir Arnold Theiler and his collaborators have now proved that the disease is caused by the ingestion of a bacterial poison or toxin elaborated by an organism closely allied to the *Bacillus botulinus* which causes the form of food poisoning in man known as botulism; lambsiekte may therefore be termed "parabotulism" (Union of S. Africa: Dep. of Agriculture, 11th and 12th Reports of the Director of Vet. Education and Research. Pt. 2. By A. Theiler, with P. R. Viljoen, H. H. Green, P. J. du Toit, H. Meier, and E. M. Robinson. Pretoria: Gov. Printing and Stationery Office, 1927). The manner in which the cattle become

poisoned is of considerable interest. The veld soil and herbage are very poor in phosphates and it does not pay to apply phosphatic manures. Consequently, the cattle suffer from phosphorus deficiency, particularly in certain districts. To supplement this deficiency the animals develop perverted appetites, which impel them to gnaw or eat substances foreign to their normal diet, such as bones, carcasses, or the offal thereof, derived from animals or game which have died on the veld. Now the toxin-producing micro-organism (*B. paratuberculosis*) inhabits the soil, may infect the carcass, and may there produce its toxin. A beast ingesting some of the toxin-impregnated offal is poisoned and thus develops the disease lamsiekte. It had long been recognised that phosphorus deficiency was in some way connected with the development of lamsiekte, and that a ration of bone-meal added to the diet would to a large extent prevent it, but the connexion between the two was unknown until explained by the present researches. Bone-meal supplies the phosphorus lacking, so that the animals do not turn to the toxin-impregnated offal to supply their needs, and are therefore not poisoned, *i.e.* do not contract lamsiekte.

FAUNA OF KARACHI.—In December 1920 a party of advanced students of the University of the Panjab, under the direction of Prof. G. Matthai, made a collecting excursion to Karachi, when a number of specimens of the polychaet genus *Eurythoe* were obtained. In October 1922, S. S. Bindra made a further collection in the same area, and his report, based on the examination of nearly five hundred specimens of the genus, is published in vol. 1, pp. 1-18, of the *Memoirs of the Department of Zoology*, Panjab University, 1927. A key to the twenty-three known species of *Eurythoe* is given, and careful descriptions are provided of the five species represented in the collection from Karachi; two of these species are described as new. The memoir is illustrated by two excellent collotype plates and by text figures. Prof. Matthai states that this is the first of a series of papers on the fauna of Karachi which is to be published.

FOSSIL DECAPOD CRUSTACEA.—In a memoir on "The Fossil Stalk-eyed Crustacea of the Pacific slope of North America" (*Bull. U.S. Nat. Mus.*, 138, 1926), Miss M. J. Rathbun gives an account of all the species of decapod Crustacea which have been found fossil in that region and describes a large number of new forms. The age of the deposits ranges from Upper Cretaceous to Pleistocene. By far the larger number of species belong to the Brachyura. The *Astacura* and *Palinura* have only a small number of representatives; one Pliocene species of the former group is referred to the genus *Astacus*. Only two species of Stomatopoda are recorded. Of the 11 genera of decapods from the Cretaceous of the Pacific slope, 10 have representatives in Europe; of the 15 from the Eocene, 11 are known in Europe; but in the Oligocene the proportion of European forms is smaller.

ATOMIC PHYSICS.—The issue of the *Proceedings of the Physical Society* for April 15 contains the presidential address of Prof. O. W. Richardson on the present state of atomic physics. He points out that although the quantum theory and the nuclear atom have admitted of great advances into the physics of atoms, they have led to difficulties which it has not been possible to overcome. Of these, the necessity for using half quanta to explain band spectra, the lengthening of the mean free path of an electron in an inert gas when the speed is reduced, and the excess of the calculated over the observed ionising potentials for the simpler gases may be mentioned. They have

led to a revolt against the views which three or four years ago held the field, and Heisenberg two years ago discarded the atomic model and dealt with the radiations only. These may be treated as the terms of a matrix and are subject to the laws of matrix algebra. Another line has been taken by de Broglie in his wave mechanics, and Schrödinger has followed it with marked success. The electron is taken as a train of waves with a group and a phase velocity, and this leads to explanations of a number of the difficulties of previous theories, although it is not free from difficulties of its own.

DIRECTION CHANGES AND FADING IN RADIO SIGNALS.—Many observations have recently been made on the phenomena of the change of direction of radio waves and on fading, that is, the fluctuation of their intensity. The results seem to depend on several factors and there is no general agreement as to which are the most important. H. J. Reich, in the *Journal of the Franklin Institute* for April, describes careful tests made to determine to what extent change of direction of the waves is connected with fading. He mentions incidentally that on one evening it was impossible to find at his observing station directional minima from any sending station. The experimenters concluded that something had gone wrong with their apparatus and gave up testing. Later on they discovered that on that evening there had been a brilliant display of the aurora borealis. It would be interesting to know why this should result in a complete absence of directional minima. The author concludes from his observations that rapid and pronounced fading is usually accompanied by rapid direction changes of large amplitude. There seems, however, to be no relation as to the exact time at which the changes occur in the two phenomena. The two phenomena often begin and end almost simultaneously. No relation could be detected in the direction changes of the signals between two different stations. There is generally a pronounced deflexion of fairly long duration shortly after sunset and shortly before sunrise. The direction of the deflexion in this case does not always verify the theory that refraction takes place at the border surface between day and night. Further experimental work seems to be desirable in order to clear up the seeming discrepancies between the results of various experimenters.

MATHEMATICAL MODELS.—Messrs. G. Cussons, Ltd., of the Technical Works, Manchester, and Thanet House, 231 Strand, W.C.2. have issued an interesting list of mathematical models, according to the collection of Messrs. Weiner and Treutlein. H. Weiner's models are mostly formed of threads, wires, and adjustable rods. This representation visualises the regular polyhedra to great advantage, one typical model showing the five cubes whose vertices are corners of a regular dodecahedron. Surfaces of the second order are illustrated by wire models showing their principal sections, generating lines, and circular sections. More elaborate systems of wires illustrate surfaces of revolution, screw surfaces, and twisted curves, including their singularities. Weiner's list also includes a variety of link polyhedra to illustrate the bending of surfaces and developables, together with a few ruled surfaces of higher order. P. Treutlein's models explain systems of measures, weight, and coinage. The simpler ones, illustrating theorems about congruent figures and areas, are followed by various prisms, cylinders, sections of cylinders and cones, and quadric surfaces. A student or teacher of solid geometry will find that such models as these help him greatly in visualising the figures with which he deals.

Foot-and-Mouth Disease.

THE ravages of foot-and-mouth disease in Great Britain during the past few years, though now, happily, declining, yet lend great importance to the discovery of methods of prevention and cure less drastic than the slaughter of all affected animals. Although in its second progress report,¹ the Foot-and-Mouth Disease Research Committee is unable to prescribe certain means of prevention and cure, the results already achieved suggest that in the future such may be discovered; thus the experiments described on methods of destroying the virus and on immunity to it in animals point the way to possible means by which these ends may be successfully accomplished.

Work on the disease is hampered by the fact that the causative agent has not yet been seen, nor has it been cultivated on artificial media. Further, it appears that there are at least two types of the virus, and infection with one, though producing immunity to this type, usually does not result in immunity to the other. The virus can only be recognised by the effects it produces in a susceptible animal such as the guinea-pig, which is chiefly used for this purpose. The same animal also serves as a useful source of the virus, since after several passages through guinea-pigs, the fluid obtained from the vesicular lesions of the disease contains virus of a very high potency, as shown by the fact that the fluid may still be infective when diluted even to 1 in 10 million.

The spread of infection of foot-and-mouth disease must depend on the natural resistance of the virus and the presence of susceptible animals. Various species which might carry the infection to cattle have been examined: rats and rabbits are relatively resistant; lesions can be produced by inoculation, but the disease does not spread from one animal to another. Cats, dogs, and hedgehogs can also be infected: no contact infections were seen, although the mortality among kittens and puppies was very high. Birds, however, were found to be insusceptible to inoculation. It is therefore probable that infection of cattle does not, at any rate easily, take place by contact with other animals: in fact, cross-infection experiments with guinea-pigs were negative unless the vesicles on the guinea-pig's feet were opened and allowed to discharge over the fodder, etc., of the cattle.

A large number of experiments were performed on

the survival of the virus under a variety of conditions. It was found that in buffered phosphate solutions of neutral reaction, potency was only slowly lost in the cold: in 50 per cent. glycerine, containing a little of the phosphate solution, the virus may also remain active for more than six months. When dried on glass slides the virus soon lost activity, especially if kept in a moist atmosphere, but on other materials the potency might be retained for a longer period, especially on hay or an infusion thereof. Carcasses of guinea-pigs, cattle, and pigs may remain infective for several weeks, especially the bone marrow. Burial with lime or salting of the carcase does not alter the period of infectivity in this tissue. The virus is destroyed by exposure to a temperature of 55° C. for about twenty minutes, by light, but not easily by chemical reagents: the most useful antiseptic is probably 0.1 per cent. commercial formalin, which always destroys it in two days at 26°-27° C.

Immunity is produced by an attack of the disease, which in the guinea-pig lasts about four months and in cattle about a year. After this period, 'partial' immunity is still present, since intracutaneous inoculation of the sole of a foot in the guinea-pig will produce local lesions, whilst intramuscular inoculation is quite ineffective. In the susceptible guinea-pig, as in cattle, there is always a difference between different sites of inoculation in the ease with which infection can be produced: thus intracutaneous inoculation or scarification of the mucous membrane of the mouth is a much more certain means of infecting than intramuscular injection. Complete passive immunity in the guinea-pig has not been produced, the injection of serum from a recovered animal giving only 'partial' immunity. Complete (active) immunity by inoculation of living virus can be produced, but the results are not very certain and an actual attack of the disease may result. On the other hand, inoculation with a formalised vaccine regularly produces 'partial' immunity in the guinea-pig, and 'complete' immunity may follow a further inoculation of living virus: this formalised vaccine is being tested for its protective powers in cattle against natural infection with foot-and-mouth disease. Another method which may be of use in the protection of cattle is to inoculate first with serum and then with the living virus. These observations suggest possibilities of the ultimate protection of farm animals, which are encouraging and may form the basis of future work along these lines.

¹ Ministry of Agriculture and Fisheries. Second Progress Report of the Foot-and-Mouth Disease Research Committee. Pp. 117. (London: H.M. Stationery Office, 1927.) 8s. net.

Recent Studies of Skilled Performances, with Reference to the Transfer of Training.¹

By Prof. T. H. PEAR.

THE popular descriptions of a person as 'clever with his hands,' or 'clever with his head,' raise some intricate problems for physiology and psychology, and in the sphere of applied science, for education, industry, and sport. For the latter vague phrase the concept of 'intelligence' has been substituted, with substantial empirical support. Tests of intelligence give results which correlate highly with each other. For the former phrase, attempts to substitute the concept of 'motor ability' (strictly speaking, of motor capacity) have met with unforeseen

and interesting difficulties. For while there seems ample evidence for the existence of a 'general intelligence,' the results of simple tests for isolated motor performances as far as possible excluding intelligence, show extremely low or even negative correlations with each other. Results along these lines corroborating earlier work by Wissler have been obtained by F. A. C. Perrin and Bernard Muscio. Moreover, in these investigations there seems to be no support for a belief in the correlation between simple motor abilities and 'intelligence.'

From such results, far-reaching inferences have been drawn, as that there is no 'general motor

¹ Substance of a paper read before the Manchester Literary and Philosophical Society on April 26.

capacity,' no 'motor type' of person, and the practical conclusion that tests for ability in any performance give valid results only when the test performance is identical with that for which the test is being administered.

It is possible to offer an alternative explanation of these results, based upon the suggestions of Sir Henry Head. The test involves the simplest muscular co-ordinations, many of them confined to limited parts of the body. Intelligence was deliberately excluded so far as possible from the tests used by Muscio. Consequently the bodily mechanisms involved in the test performances may have required comparatively low levels of the nervous system. The test results would not exclude the possibility that a higher, more complex power may use and co-ordinate these simple mechanisms in ordinary 'skilled' performances.

In this connexion it is important to consider the rôle of the motives in acquiring muscular skill. It cannot be assumed that those motives urging university graduates and undergraduates (the performers in these tests) to do their very best in a simple, apparently trivial, and often boring motor test are identical with those producing keenness in a test of intelligence.

There appear to be reasons for restricting the word skill to more complex motor performances, a skilled human action being described as a highly integrated learned adjustment. The above tests would then be described as of simple motor *abilities*.

Another method of investigating the problem of 'motor ability or motor abilities' is to reset it in the form of the 'transfer of training.'

Subjects may be intensely trained in some definitely skilled activity, so that their curve of practice shows a considerable rise over a long period. It may then be discovered whether the undoubted ability gained in the test activity has been transferred to apparently closely related performances. Such an investigation obviously requires controls of a kind which cannot be described here.

Though much work upon the relation of general to specific training has been done with regard to such powers as memory, sensory discrimination, etc., little is known of this problem as it relates to skill. Recently, C. E. Beeby has investigated the transfer of ability between performances requiring the use of one or both hands. He found an *initial positive transfer* which gradually diminished with further practice until it became a *final negative transfer* or interference. The actual amounts of transfer (initial and final) in his tests were the same whether it took place from (a) one hand to the other, (b) a double-handed action to one of the single-handed movements comprising it, (c) a single-handed to a double-handed action. He concludes that the only transfer was of general mental attitude. There was no evidence of positive transfer of specific habits of manipulation. Nothing but interference was shown between these specific habits. This it is which explains the final negative transfer as distinct from the initial positive transfer, due to 'carry over' of mental attitude.

An extensive investigation into the transfer of motor training is being carried out, under the auspices of the Industrial Fatigue Research Board, by J. N. Langdon and Edna M. Yates. Certain experimental conditions (such as adequate motivation of the learners, a skilled performance as the test-activity, the training of controlled subjects under comparable conditions, the simultaneous provision of analytic tests) being strictly observed, it is possible that the results will be of interest to psychology, industry, and sport.

University and Educational Intelligence.

CAMBRIDGE.—Mr. H. E. Woodward, Trinity College, has been appointed University lecturer in engineering. Dr. C. M. Yonge, Edinburgh, has been elected Balfour student. The Faculty Board of Mathematics proposes the restoration of the title 'Stokes Lecturer' to be attached to one of the University lectureships in mathematics.

The report of the Committee for Geodesy and Geodynamics gives the result of the pendulum observations made in July 1921 by Mr. G. Manley on Sabine Island. Helmert's value for g at sea-level at latitude $74^{\circ} 32' 19''$ N. is 982.849. Sabine's determination gave 982.785, while Manley's value is 982.888. The larger value of g is what would be expected at an island station, judging from other observations elsewhere. The pendulums used by Mr. Manley in Mr. Wordie's expedition to East Greenland are the same as those taken with the Scott expedition to the Antarctic. It is welcome news that the Ordnance Survey and the Geographical Section of the General Staff propose to co-operate in a gravity survey of Great Britain.

Research studentships are advertised at Pembroke College, the Stokes studentship in mathematical or experimental physics, physical chemistry or the study of physical laws in relation to living matter; at Clare College, the Denman Baynes studentship in mathematics, physics, or chemistry; and at Peterhouse, the Charles Abercrombie Smith studentship for research in any approved subject.

EDINBURGH.—As Munro Lecturer for the present year, Prof. G. Baldwin Brown is delivering a course of ten lectures during this term on "The Activities of Prehistoric Man in their Relation to the Origins of the Arts."

On June 6 and 7, Dr. H. H. Dale delivered the two Cameron prize lectures for this year, taking as his subjects "The Nature and Action of Insulin" and "Capillary Circulation and its Chemical Control."

Mr. Thomas Cowan, of Leith, has offered the University a sum of £40,000, the interest of which is to be used to meet administration and maintenance costs of the University hostel with which his name is to be associated through previous gifts to the University.

OXFORD.—Prof. A. M. Carr-Saunders of Magdalen College, professor of social science at the University of Liverpool, has been appointed Herbert Spencer Lecturer for 1928.

A RESEARCH fellowship of the value of £500 is being offered by the Australian Federation of University Women to women graduates of British universities, excluding those of Australia, Tasmania, and New Zealand. The fellowship is for research in biology, anthropology, geology, economics, or colonial history. Applications must be received by June 30, by the Secretary, British Federation of University Women, Crosby Hall, Cheyne Walk, S.W.3.

A LIMITED number of research scholarships in technology, each of the value of not more than £100, will be awarded by the Manchester College of Technology in July next. Research may be undertaken in any of the following departments:—mechanical engineering, electrical engineering, municipal and sanitary engineering, applied chemistry, textile industries, photographic technology, printing, and industrial administration. Forms of application, returnable by, at latest, July 6, may be obtained from the Registrar of the College.

At the annual meeting of shareholders of the Burmah Oil Company, held in Glasgow on June 10, Sir John Cargill announced that the directors had offered £100,000 to establish a college of mining and engineering in the new University of Burma, to be associated in some way with the name of the company.

THE Medical Research Council announces that on behalf of the Rockefeller Foundation the following awards of medical fellowships provided by the Foundation and tenable in the United States of America during the academic year 1927-28 have been made. These fellowships are awarded to graduates who have had some training in research work either in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in America before taking up positions for higher teaching or research in the British Isles: Mr. R. W. F. Collis, King's College Hospital, London; Dr. D. Krestin, London Hospital; Mr. G. L. Peskett, University of Oxford; Dr. Isabella M. Robertson, Maudsley Hospital, London; Mr. T. Tennant, Maudsley Hospital, London; and Dr. E. W. Todd, St. Mary's Hospital, London.

FROM the League of Nations Union we have received two pamphlets dealing with topics which might well come before the Imperial Education Conference to be held on June 20. They deal with the League of Nations as a subject of instruction in the schools of Great Britain. One is a report on work done by the Union to promote such instruction. It shows that the measures recommended by the League's sub-committee of experts on the subject, in so far as they depend on the initiative of voluntary associations, have already been adopted energetically and successfully in Great Britain, where they are perhaps less needed than elsewhere. The other pamphlet, "The Schools of Britain and the Peace of the World," is a memorandum signed by representatives of all classes of secondary and elementary schools as well as training colleges. The signatories express agreement with the League's experts on the main issue and, so far as they do not trench on the freedom of teachers, their detailed recommendations. They point out that "the study of international co-operation in the modern world should develop from those studies of modern history and geography which form part of the general school education of every boy and girl," but do not recommend for it a separate place in the curriculum. They uphold the Wilsonian doctrine of loyalty to humanity, which should not be difficult for a citizen of the British Commonwealth—itsself a model League of Nations: "Disloyalty to the whole involves disloyalty to every part, including one's own state." Appended are some useful notes by Mr. F. S. Marvin on the international aspects of history.

A NOTE on the International Labour Organisation of the League of Nations has been prepared by the League of Nations Union and associations of teachers as an addendum to the "Schools of Britain" pamphlet, referred to in the preceding paragraph, which was submitted to the Board of Education for consideration in connexion with the National Conference of Education Authorities in Great Britain and Northern Ireland. The note directs attention to the modern tendencies to emphasise, in the teaching of history and geography in schools, social developments and industrial conditions rather than names of celebrities and dates of events and names of towns and rivers. It points out that the proposal that the social activities of the League, and, in particular, of the International Labour Organisations, should be noticed in the course of history and geography lessons accords well with these tendencies.

Calendar of Discovery and Invention.

June 19, 1799.—Goethe under this date wrote: "Late in the evening, when the twilight was passing into a clear night, as I was walking up and down with a friend in the garden, we remarked very plainly about the flowers of the Oriental poppy, which were distinguishable above everything else by their brilliant red, something like a flame. We placed ourselves before the plant, and looked steadfastly at it, but could not see the flash again, till we chanced in passing to look at it obliquely; and we could repeat the phenomenon at pleasure."

June 20, 1773.—The famous Collège de France, founded by Francis I. in 1530, has been the home of many eminent scientific men. In the seventeenth and eighteenth centuries, however, its chairs were often given as rewards for social service. Its reorganisation was due to an Order in Council of June 20, 1773, and after this it became the rendezvous of fashionable crowds who thronged to hear the lectures of Lalande, Rouelle, Daubenton, and others. Biot, Ampère, Regnault, and Berthelot have been among its most famous professors.

June 21, 1835.—In 1830 the Emperor of Russia declared "that the honour of the country appeared to him to demand the establishment, near the capital, of a new astronomical observatory, conformable to the actual state of science, and capable of contributing to its ultimate advancement." The outcome of this was the erection of the magnificent observatory of Pulkowa, the foundation-stone of which was laid on June 21, 1835. Gould once described Pulkowa as the astronomical capital of the world.

June 21, 1849.—Joule's work on the connexion of heat and work was done between 1840 and 1850. He employed various methods in his experiments, but his final results were obtained with the water-friction apparatus now preserved in the Science Museum, South Kensington. His epoch-making paper which gave us the unit, 772 foot-pounds, was entitled, "On the Mechanical Equivalent of Heat," and was communicated to the Royal Society on June 21, 1849, by Faraday.

June 21, 1860.—In 1839 Hooker sailed for the Antarctic with Sir James Ross. The expedition was away four years. One of the results of Hooker's work was his valuable memoir, "Outlines of the Distribution of Arctic Plants," read before the Linnean Society on June 21, and published in the Society's *Transactions* with a map.

June 22, 1857.—When the Great Exhibition of 1851 closed, the Commissioners had a balance of about £180,000. With this they bought the tract of land at South Kensington on which now stand the National Museums and Colleges. The first of these to be erected was the South Kensington Museum, which formed the nucleus of the Victoria and Albert Museum and the Science Museum. The original building, an ugly iron structure long known as the 'Brompton Boilers,' was opened by Queen Victoria on June 22, 1857. The present Victoria and Albert Museum was opened by King Edward in 1909, while the first part of the new Science Museum is nearing completion.

June 24, 1784.—The Council of the Royal Society having petitioned George III. for funds to carry out a geodetical survey for connecting the observatories of Paris and Greenwich, on June 24, 1784, the president informed the Council that the King had agreed to the undertaking, "and had permitted Major-General Roy to proceed in the execution of the plan under the direction of the President and Council of the Royal Society."

E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, May 13.—Lieut.-Col. A. T. Gage: Alkaloids are yielded chiefly by the following plants, *Aconitum Napellus* L. (aconite); *Berberis aristata* DC. (berberin); *Papaver somniferum* L. (morphine and other alkaloids); *Camellia Thea* Link. (caffeine); *Theobroma Cacao* L. (theobromine); *Erythroxylum Coca* Lamk. (cocaine); *Pilocarpus pennatifolius* Lem. (pilocarpine); *Physostigma venenosum* Balf. (physostigmine or eserine); *Conium maculatum* L. (conine); Cinchona, various species (quinine and allied alkaloids); *Coffea arabica* L. (caffeine); *Psychotria Ipecacuanha* Stokes (emetine); *Strychnos Nux vomica* L. (strychnine); *Nicotiana Tabacum* L. (nicotine); *Datura Stramonium* L. (datarine); *Atropa Belladonna* L. (atropine); *Hyoscyamus niger* L. (hyoscamine); *Claviceps purpurea* Tul. (ergotine).—T. A. Henry: During the century that has elapsed since the discovery of the first alkaloid, morphine, great progress has been made in our knowledge of these indispensable drugs. Such well-known alkaloids as cocaine and atropine have been made in the laboratory, the synthesis of quinine and the related cinchona alkaloids may be expected at any time and, except in minute details, experts are now agreed as to the structure of even such a difficult alkaloid as morphine. Though supplies of alkaloids are still drawn wholly from natural sources, there has been no intensive study of the bio-chemistry of alkaloids, and virtually nothing is yet known regarding either the methods by which alkaloids originate in plants or the part they play in plant physiology.

Royal Microscopical Society, May 18.—R. R. Gates and J. Latter: Observations on the pollen development of two species of *Lathraea*. The two species of *Lathraea*, *L. clandestina* and *L. squamaria*, are similar in all stages of pollen development, the haploid chromosome number in each being twenty-one. Crystal-like bodies are present in the nucleoli of the resting pollen mother-cells. The threadwork remains a reticulum after synzesis, and chromosome formation apparently takes place by the chromatin flowing into definite aggregations irregularly distributed along the branched threads. In diakinesis the filaments connecting the chromatic aggregations are absorbed and the bivalents become independent of one another. During the entire process of chromosome formation the reticulum is connected to the nucleolus, dark-staining nucleolar bodies marking the points of attachment. The portions of thread nearest the nucleolus are sometimes much thickened as though by an exudation of nucleolar material. The method of chromosome pairing is intermediate between parasympsis and telosynapsis. The heterotypic and homotypic divisions occur normally, except for an extremely late appearance of the homotypic split. Cytomyxis is observed in prophase and interkinesis. The tapetum on the outer wall of the loculus is differentiated from that on the inner, the former being constantly uninucleate, the latter binucleate throughout all the stages of pollen development.—James Lomax: The preparation and examination of coal sections. Sections sufficiently large to enable the whole thickness of a coal seam to be examined in detail have been prepared. All coals are composed of the remains of vegetable matter which can be divided into four components, clarain, vitrain, durain, and fusain. Clarain, which forms the bulk of most British coal seams, has a bright lustrous appearance and is composed of a mixture of leaves, wood, resinous

bodies, etc., in a matrix of structureless material. Vitrain also has a bright lustrous appearance, but usually breaks with a conchoidal fracture. It is derived from wood in which all trace of structure has been destroyed, and usually occurs in thin bands and lenticles in the other components. Durain is a dull variety of coal composed mainly of the exines of megaspores and microspores; it often contains a high percentage of ash, but if pure it forms some of the best British coals. Fusain, commonly known as 'mother of coal' or 'mineral charcoal,' is very soft and has a dull black appearance. It occurs as thin bands and lenticles and is present in all coal seams. It is derived from wood from which all the volatile matter is driven off, but the cellular structure is often well preserved.

Physical Society, May 27.—Edgar A. Griffiths and Ezer Griffiths: A duplex reversal key with mercury contacts. The key employs mercury contacts and is enclosed in a glass casing. The two upper fixed contacts consist of downwardly projecting copper rods, the two lower fixed contacts of cups containing mercury, and the two movable contacts of downwardly projecting copper rods (which enter the fixed cups in one position of the switch) surmounted by cups of mercury (which receive the fixed rods in the other position of the switch). The connexions are those of a reversing switch, and the middle contacts can be raised or lowered by turning a vertical shaft which is retained in either position by a jockey spring.—L. Hartshorn: The measurement of the inductances of four terminal resistance standards. The method of measurement is an application of the Kelvin double bridge, used with alternating current, the phase angle adjustment being obtained by condensers shunting the ratio arms. The bridge is free from stray fields, practically independent of frequency, capable of use with almost any desired current strength, and is very easy to work.—C. Chree: Magnetic disturbance and aurora as observed by the Australasian Antarctic Expedition at Cape Denison in 1912 and 1913.

SHEFFIELD.

Society of Glass Technology, April 27.—W. E. S. Turner: A brief review of furnace development. (a) A saving in fuel has been obtained by the newer types of recuperative or regenerative furnaces; (b) heavy expense was incurred by the practice of founding only once a week; (c) the fuel consumption was greatly increased when the eye of the furnace had worn big. The efficiency of modern British pot furnaces compares favourably with those of Germany. Among the improvements effected during the last few years in furnace design have been (1) greater compactness, (2) better utilisation of waste heat, (3) the introduction of tangential burners, and (4) sillimanite sieges. Tank furnace practice generally on the Continent has not reached the British attainment, which is now equal to anything yet achieved in America. Among the problems which still require more thorough examination are: (a) Design of ports; end ports in some cases appear to give longer life to tank blocks; (b) bridges, the form of the basin and whether there should be one or two dog-houses; (c) depth of the refining end of the tank, whether it should be less than that at the melting end; (d) increased insulation in various parts of the furnace crown, side-walls, etc., and (e) utilisation of waste heat.

PARIS.

Academy of Sciences, May 9.—Jean Perrin: Fluorescence and molecular induction by resonance.

Charles Richet: The conditions of death in electric tetanus in fishes. In fishes, death by electric shock occurs more quickly in small than in large fish of the same species. Fish of different species differ greatly in their resistance to electric shock, and death by electrification is more rapid the higher the temperature of the fish.—A. Bigot: The conditions of deposit of the lower Bathonian in the Bessin and in the region of Caen.—Gaston Julia: The conformal representation of simply connected areas.—Maurice Gevrey: Green's functions: the image point, frontiers with singular points.—Mlle. N. Bary: The finite representation of continued functions.—Haroutune Anjour: New types of the case of movement of the solid body.—G. Reboul: The mechanism of the emission of a radiation by cells of great electrical resistance.—V. Dolejšek: Remarks on the principle of combination.—Privault: The action of the antioxygens on fluorescence. The introduction of a considerable quantity of hydroquinone into a fluorescent solution causes a diminution in the fluorescent power, which almost completely disappears in a concentrated solution of hydroquinone. It is probable that all antioxygens will prove to act similarly.—Francis Perrin: Induced de-activation of the molecules and the theory of antioxygens.—Mlle. Suzanne Veil: The evolution of the hydrate of cobalt sesquioxide in the presence of water. The changes undergone by the hydroxide are followed by the changes produced in the magnetisation coefficient.—Jean Bayol, Paul Marcelin, and Lucien Mayet: A cave with drawings on the walls of the reindeer age in the valley of Gardon: the 'Baoumo-d'en-aut' at Collias (Gard). This cave contains, besides human bones, remains of reindeer, horse, and other animals. It is remarkable for the drawings on the walls—painted, and not engraved.—A. Maige: Remarks concerning the origin of the amylase in plant cells.—Maurice Lenoir: The formation of antipodal nuclei in the embryonic sac of *Fritillaria imperialis*.—George F. Jaubert: The origin of the coloration of beeswax and the composition of propolis. The colouring matter has been identified as 1,3-dioxyflavone. This is derived from the propolis and is not present in the beeswax before melting out.—Auguste Lumière and Mme. Montoloy: The mode of action of autohæmotherapy.—S. Schmidt: The velocity of flocculation and velocity of neutralisation of the antitetanus serum towards the tetanus toxin. The value of a tetanus antitoxin does not depend solely on the amount of antitoxin in the serum; the velocity of flocculation is also an important factor.

BRUSSELS.

Royal Academy of Belgium, Oct. 9.—M. Dehalu: A law of gravitation analogous with that of Einstein.—J. E. Verschaffelt: The trend of the curves of fusion and of sublimation of a pure body.—Paul Stroobant: Discovery and observations of minor planets at the Royal Observatory of Uccle.—Th. de Donder: (1) Contribution to the relativistic quantification. (2) Electrostriction deduced from the Einsteinian gravific. —Fréd. Swarts: (1) Trifluoroacetylacetic acid and ester. The great stability of trifluoroacetic acid suggested that the condensation of ethyl trifluoroacetate with ethyl acetate to form trifluoroacetylacetic acid might be possible, and this reaction has been found to take place. The acid is very stable; it can be crystallised and even distilled. (2) Trifluoroacetylacetic ester. (ii.) Details of the preparation study of the enol \rightleftharpoons ketone equilibrium. (3) Trifluoroacetylacetic acid.—Lucien Godeaux: Researches on algebraic surfaces of genus zero and bigenus unity.—P. Swings: The Riemannian potentials and the Einstein quadratic forms in the problem of two bodies.—

A. Macq: Contribution to the study of the unsaturated nitriles of the fatty series.—F. Petit: Contribution to the study of the reaction between the organo-magnesium compounds and the nitriles. The γ -amino-nitriles. γ -piperidobutyronitrile behaves as a pseudo acid towards magnesium compounds of the fatty series and there is no synthetic reaction. With the phenyl and benzyl magnesium compounds, on the contrary, the reaction is normal.—M. Theunis: Contribution to the study of the reaction of the organo-magnesium compounds on the nitriles. The α -chloronitriles.—Marc de Hemptinne: The thermal expansion of metallic combinations. The coefficient of expansion of a series of silver-antimony alloys has been measured by means of a simple instrument, a description and diagram of which is given. The abrupt change in the coefficient of expansion for the alloy containing 73 per cent. silver, gives clear indication of the existence of the compound Ag_3Sb .—Théodore Van Hove: (1) Contribution to the study of the nitration of the mixed dihalogen derivatives of benzene. Experiments on the nitration of *p*-bromofluorbenzene. (2) Second communication. Study of the nitration of *p*-iodofluorbenzene and *p*-iodochlorobenzene.—C. Balasse and O. Goche: Study of the luminescence of caesium vapour in the electrodeless discharge.—Maurice Nuyens: The electron with internal pressure.

Nov. 6.—Th. de Donder: The electronic gas.—Constant Lurquin: The law of probability of Cauchy.—Georges Homès: The electrodeless discharge and active nitrogen. Details of the phenomena produced in nitrogen by the electrodeless discharge and discussion of the interpretation of the results obtained.

Dec. 4.—J. Capart: The excavations at Spiennes. The committee appointed to investigate the discoveries of M. Rutot had not been able to confirm them.—Lucien Godeaux: Researches on the algebraic surfaces of genus zero and bigenus unity.—H. Bittenbach: Description of a mineral from Katanga. This mineral was found in the Prince Leopold mine at Kipushi and has been tentatively named kipushite. It is a basic phosphate of copper and zinc $(\text{Cu,Zn})_3(\text{PO}_4)_2 + 3(\text{Cu,Zn})(\text{OH})_2 + 3\text{H}_2\text{O}$. A complete crystallographic study is given. The same mineral has been discovered in the Rhodesian Broken Hill mine.—A. Juliard: The formation of ozone by the silent electric discharge in the presence of foreign gases. In the presence of hydrogen, silicon tetrafluoride, nitrogen and nitric oxide, the yield of ozone is lowered, other conditions remaining constant. This result is in contradiction with some of the earlier work on the same subject.—G. Gilta: The crystalline form of sodium β -glycerophosphate.—Théodore Van Hove: Some researches on the direct introduction of substituting groups in the aromatic mercaptans. Studies in the bromination, nitration, and sulphonation of thiophenol.

Dec. 15.—A. Rutot: Remarks on the discoveries at Spiennes.—Victor Van Straelen: The first remains of medusæ found in the carboniferous limestone of Belgium.—Jeanne Terby: Study of the chromocentres of the cells of the root nodosities of the Leguminosæ.

ROME.

Royal National Academy of the Lincei, April 3.—V. Volterra: The periodicity of biological fluctuations. The author has already extended to the hereditary case the three laws of biological fluctuations, the modifications which they undergo being indicated. It is now shown that in the same case small periodic fluctuations round the stationary state are incapable of existence.—F. Severi: (1) Reflections on the area of a curved surface; (2) Further with regard to the

area of a curved surface.—G. Albanese: The fundamental theorem of the base for the whole of the curves of an algebraic surface.—G. Dubourdieu: Groups of holonomy of Riemann spaces of four dimensions. Case of a definite and positive ds^2 .—G. Andreoli: Curvature and parallelism on a surface.—L. Fantappiè: The analytic functionals of functions of two complex variables.—U. Crudeli: The motions of a viscous (homogeneous) liquid symmetrical with respect to an axis.—M. L. Pagliarulo: Natural refractive and rotatory dispersion of aqueous solutions of monoethyl aspartate. This ester exhibits anomalous natural rotatory dispersion, the curve showing at the wave-length region 5300-6300 Å.U., a bend similar to that of the curve of refractive dispersion when absorption bands occur. The refractive dispersion curve runs perfectly parallel to that of water, but the curve representing the increments for 100 Å.U. shows a flattened portion, the middle of which coincides with the bend of the rotatory dispersion curve. Thus, monoethyl aspartate exhibits a vibration with characteristic frequency corresponding with wave-length 5780 Å.U.—G. Malquori: The system, $AlCl_3-KCl-H_2O$ at 25° . No double salts are observed in this system, the two solid salts existing in contact with the solutions being $AlCl_3 \cdot 6H_2O$, and KCl . Thus, although anhydrous aluminium chloride readily forms double compounds, no tendency in this direction is shown by the hydrated salt.—P. Aloisi: Approximate determination of 2V in thin mineral sections.—R. Savelli: The genetic value of the products of *Nicotiana rustica* \times *Nicotiana tabacum*.

VIENNA.

Academy of Sciences, Mar. 24.—E. Röggl: The theory of errors on a geometrical foundation.—A. Tauber: On the integration of linear differential equations.—H. Benndorf: Contributions to our knowledge of atmospheric electricity (No. 68). Outlines of a theory of the electrical field of the earth. It is assumed that the conductivity of the atmosphere increases with height, so that at some 20 kilometres height the conductivity may be a hundredfold that at the ground level, and hence the field only one hundredth of that at the ground level, 99 per cent. of the charge being compressed within the lower 20 kilometres of the atmosphere.—L. Schmid and A. Waschku: The phyto-sterins of beet oil.—K. Brunner, R. Gruner, and Z. Benes: Preparation of di-propion- amide and di-iso- butyr- amide.—K. Brunner, M. Matzler, and V. Mossmer: Formation of amides.—K. Brunner and F. Haslwanger: Formation of nitro-phenyl-ethane-amides.—M. Holly: Mormyridæ, Characinidæ and Cyprinidæ from Kamerun.—P. Weiss: Tests of potency on the regeneration blastema of the lizard. In continuation of former experiments on Triton, portions of lizard's tails were transplanted to the foreleg of the same animal.—M. Kohn and J. Sussmann: Some halogen phenols derived from o-chloro-phenol.—M. Kohn and J. Sussmann: The di-phenyl-ether of 2, 5- di-oxy-quinone and allied compounds.—M. Kohn and J. Pfeiffer: Removal of halogen from bromo-phenols.—M. Kohn and J. Pfeiffer: Halogenation of chloro-phenols.

Official Publications Received.

BRITISH.

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1926; with Reports and Notes of the Director, Rev. E. D. O'Connor. Pp. xii+48. (Blackburn.)
Methods of Growing Large Metal Crystals. Being the Fourth Sorby Lecture delivered by Prof. H. C. H. Carpenter on Friday, October 22nd, 1926. Pp. 32+7 plates. (Sheffield: Department of Applied Science, The University.) 1s.

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Manchester Municipal College of Technology. Prospectus of Short Courses of Lectures and Laboratory Work to be given during the Summer, 1927. Pp. 27. (Manchester.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 11: The Fish-Fauna of the Cementstones of Foulden, Berwickshire. By Errol Ivor White. Pp. 255-287. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4s.

Sudan Government: Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1926. (Chemical Section, Publication No. 43.) Pp. iii+34. (Khartoum.)

The Journal of the Royal Agricultural Society of England. Vol. 87. Pp. 356+clxvi+x+20. (London: John Murray.) 15s.

Memoirs of the Department of Zoology, Panjab University. Vol. 1: Fauna of Karachi. 1: A Study of the Genus *Eurythoe* (Family Amphinomidæ). By S. S. Bindra. Pp. 18+2 plates. (Lahore: Panjab University.) 3 rupees.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1925-26. Pp. iv+36. 6d. Report on the Agricultural Department, St. Kitts-Nevis, 1925-26. Pp. iv+30. 6d. (Trinidad, B.W.I.)

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 14, No. 4, May. Pp. 537-1101. (Plymouth.) 10s. net.

Transactions of the Yorkshire Numismatic Society. Edited by T. Sheppard. Vol. 3, Part 1. Pp. iv+56+2 plates. (Hull: A. Brown and Sons, Ltd.) 5s.

Journal of the Chemical Society: containing Papers communicated to the Society. May. Pp. viii+iv+961-1221. (London: Gurney and Jackson.)

Aeronautical Research Committee: Reports and Memoranda. No. 1070 (Ae. 252): Wind Tunnel Test of Aerofoil M.2. By H. Davies and F. B. Bradfield. (A.S.A. Aerofoils-General, 170.—T. 2363) Pp. 5. (London: H.M. Stationery Office.) 4d. net.

A Report on Work done by the League of Nations Union to help in making known the League of Nations in the Schools and Colleges of Great Britain. Pp. 20. (London: League of Nations Union.)

The Schools of Britain and the Peace of the World. Pp. 35. (London: League of Nations Union.)

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich; read at the Annual Visitation of the Royal Observatory, 1927 June 3. Pp. 22. (Greenwich.)

Pasteur Institute of India, Kasauli. The Twenty-fifth Annual Report of the Central Committee of the Association and the Audited Accounts up to June 30th, 1926; also the Report of the Director of the Institute for the Year ending 31st December 1925. Pp. 80. (Kasauli.)

Kodaikanal Observatory. Bulletin No. 80: Summary of Prominence Observations for the first half of the Year 1926. Pp. 119-133. (Kodaikanal.)

Records of the Geological Survey of India. Vol. 59, Part 4, 1926. Pp. viii+371-422+xxvi. (Calcutta: Government of India Central Publication Branch.) 2.12 rupees; 5s.

Memoirs of the Geological Survey of India. Palæontologia Indica, New Series. Vol. 10, Memoir No. 2: The Mollusca of the Ranikot Series (together with some Species from the Cardita Beaumonti Beds). By M. Cossman and G. Pissarro, revised by the late E. Vredenburg, with an Introduction and editorial Notes by Dr. G. de P. Ooster. Pp. v+31+4 plates. (Calcutta: Government of India Central Publication Branch.) 2.6 rupees; 4s. 3d.

Proceedings of the Edinburgh Mathematical Society. Edited by Dr. T. M. MacRobert and Prof. H. W. Turnbull. Series 2, Vol. 1, Part 1, May. Pp. 70. (London: G. Bell and Sons, Ltd.)

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. Seeds Mixture Problems. (Series H, No. 6, Seasons 1923-1926.) Pp. 70+2 plates. (Aberystwyth.) 3s. 6d.

Proceedings of the South London Entomological and Natural History Society, 1926-27. Pp. xix+155+11 plates. (London.) 15s.

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 2, No. 8: The Role of Inbreeding in the Development of the Clydesdale Breed of Horses. By A. Calder. Pp. 118-140. 2s.

Vol. 47, Part 2, No. 9: Models Illustrative of the Atomic Process in Ferromagnetism. By Sir J. Alfred Ewing. P. 141. 6d. Vol. 47, Part 2, No. 10: The Salmon of the R. Grand Cascadepia, Canada. By W. L. Calderwood. Pp. 142-147+2 plates. 1s. 6d. Vol. 47, Part 2, No. 11: The Effects of Implantation upon Ovarian Grafts in the Male Mouse. By Y. Tamura. Pp. 148-164+2 plates. 2s. 3d. Vol. 47, Part 2, No. 12: Magnetisation and Temperature in Crystals. By Prof. W. Peddie. Pp. 165-170. 1s. Vol. 47, Part 2, No. 13: After Images of Coloured Sources. By Miss W. J. Smith. Pp. 177-189. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

FOREIGN.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 8, 1926. 1: Månadsoversikt över vädret och vattenföring samt anstaltens årsberättelse. Pp. 99. (Stockholm.) 2.50 kr.

Société des Nations: League of Nations. Bulletins de l'Institut International de Coopération Intellectuelle. Bulletin des relations scientifiques, 2me année, No 2, Mai. Pp. 229-308. (Paris: Les Presses universitaires de France.) 8 francs.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 26, Part 1: The Lecythidaceae of Central America. By H. Pittier. Pp. v+14+12 plates. Bulletin 100, Vol. 2, Part 5: Contributions to the Biology of the Philippine Archipelago and adjacent Regions. The Shipworms of the Philippine Islands. By Paul Bartsch. Pp. 531-562+plates 53-60. 15 cents. Bulletin 100, Vol. 6, Part 3: Contributions to the Biology of the Philippine Archipelago and adjacent Regions. Report on the Hydroids collected by the United States Fisheries Steamer *Albatross* in the Philippine Region, 1907-1910. By Charles C. Nutting. Pp. 193-242+plates 40-47. 15 cents. (Washington, D.C.: Government Printing Office.)

Proceedings of the Imperial Academy. Vol. 3, No. 3, March. Pp. v+vi+116-193. (Tokyo.)



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Organisation and Registration of Chemists.

IN a recent leading article (*NATURE*, June 4) attention was directed to a notable achievement in chemical co-operation exemplified by the recent publication of a volume of abstracts covering the whole field of pure and applied chemistry, issued under the direction of the Bureau of Chemical Abstracts. This unifying enterprise is a significant manifestation on the literary side of a wider movement towards the consolidation and standardisation of the chemical profession within the British Empire. Another aspect of chemical co-ordination is revealed by the remarkable growth in membership and in national importance of the Institute of Chemistry, which this year celebrates its jubilee. This record of progress is admirably reviewed in a recent lecture to the Institute by its immediate past president, Mr. A. Chaston Chapman.¹

In the years immediately preceding the birth of the Institute, there was little or no professional cohesion among those who then practised chemistry either as a whole-time profession or as an addition to such other vocations as medicine, pharmacy, or engineering. In the absence of any code of professional ethics, it was inevitable that marked inequalities should exist in regard to the status and qualifications of chemical practitioners. Even the designation of chemist became misapplied systematically until, as the result of general usage, the term was taken to denote a member of another and better-known profession, that of pharmacy.

In 1876 a meeting of prominent chemists resolved “that it is desirable that an organisation of professional chemists be formed,” and this resolution furnished the germ from which the Institute of Chemistry developed. The immediate objectives were the protection of qualified chemists from the unfair competition of unqualified men and a raising of the standard of professional ethics. The latter aim has been steadily pursued, and with noteworthy success, for although in 1893 the censors of the Institute reported that practices of an unprofessional character were unduly prevalent, yet in the last few years the censorship has had to deal only with cases of slight misunderstanding, and instances of serious misconduct have happily become exceedingly rare.

In 1878 the number of chemists who desired to join the Institute, and whose claims had been approved, was 225, and by 1914 the total member-

¹ The Growth of the Profession of Chemistry during the Past Half-century (1877–1927). By A. Chaston Chapman. (London: Institute of Chemistry, 1927.)

ship of fellows and associates was in the neighbourhood of 1400. During the intervening years the Institute had become sufficiently powerful and exclusive to impose examinational tests on applicants for the associateship, even when such candidates possessed high academic distinctions and had gained considerable industrial experience. At first these tests were entirely practical, and the essential qualification of an aspirant for the associateship was proficiency in the laboratory arts. Later, however, written papers in chemistry, and exercises in translation from French and German chemical literature, were set to candidates whose scientific training had not been taken at a recognised college or university. Very occasionally, older chemists of outstanding eminence and experience were admitted to the senior grade of fellow without examination.

During the upheaval of the War years, other avenues into the Institute were opened for those who had made good as chemists either in the fighting services or in chemical factories producing munitions of war, and although the expediency of this step was contested at the time, the later history of the Institute has proved the wisdom of a judicious opening of the doors without examination in cases which, after careful scrutiny, had been recommended by a zealous Nominations and Examinations Committee.

This provision of alternative methods of qualifying for membership came very opportunely at a time when the sudden realisation by the nation of the fundamental importance of applied chemistry as a key industry led to a rapid growth in the number of chemical practitioners, and to a remarkable development in the schools of chemistry, where many more students than heretofore were entering on courses of higher instruction and research. At present, the total membership of the Institute is approximately 5200, so that after a brief half-century of steady growth this professional body may now claim to include a majority of the practising chemists of the British Empire. The progress of the Institute is not, however, to be measured entirely in terms of increased membership, but rather in relation to the greatly enlarged scope of its activities for the nation as well as for the profession. Government departments and other public bodies consult the Institute and accept its help to an extent unknown in the earlier days.

Within the profession the Institute has been a rallying-point for chemical altruism. It holds out a helping hand to all chemists whether members

of the Institute or not, although obviously the assistance is more effective in the former alternative. Students of chemistry can become registered students of the Institute and are thus eligible to receive its publications and to use the library. They are also invited to its scientific meetings and social gatherings. The appointments register, which gives prompt and ready access to lists of suitable vacancies, has done inestimable service in reducing to small proportions the amount of unemployment. Even in the leanest years of industrial depression the unemployed have been less than four per cent. of the total membership, and in the last resort the benevolent fund of the Institute operates in hard cases of undeserved misfortune.

A review of the present position of organised chemists would, however, be incomplete without reference to another professional organisation, the British Association of Chemists, which came into existence in 1917 as the outcome of a feeling among certain of the younger chemists that the Institute, by reason of its charter, was precluded from taking active steps in such matters as trade disputes, individual or collective bargaining with employers, and in other cases where the material advantage of its members was involved. The prime movers in this development were at first uncertain whether to start the Association as a limited liability company or as a trade union, but ultimately the latter course was adopted, thus bringing the Association into harmony with the operation of the Whitley Councils as applied to the chemical profession.

The Association, which is now a registered trade union although not affiliated with the T.U.C., has a membership of about 1000, of whom about 25 per cent. are also members of the Institute of Chemistry. It is of interest to note that the Association, like the Institute, is representative of all branches of the chemical profession. The Association has its own appointments register and a legal aid department. One of its most beneficent works has been the disbursement of £4000 in unemployment pay during the last two years. This practical demonstration of brotherhood and mutual assistance is one of which all British chemists should be proud, whether they are members of the Association or not.

The foregoing brief sketch of the activities of the two professional bodies depicts a widespread movement towards unification in the chemical profession, but the picture would be unfinished and out of true perspective without an outline of

another modern tendency which makes for disunion and separatism.

When systematic training in chemistry first began in Great Britain, students received a comprehensive training in chemistry and the allied sciences, and at the end of such a training went out with the simple label of chemist. The choice of allied sciences naturally varied from one college to another, but this variation did not alter the main intention of the curricula, which was to produce a well-trained student of chemistry. Such were the courses at the old College of Chemistry and at its successor, the Royal College of Science. In the now defunct Finsbury Technical College, chemical students devoted the major part of their first two years of study to engineering subjects, but they were not on that account called chemical engineers. They were primarily chemists who, on reaching the works, found that their elementary acquaintance with engineering was of real service to them.

Nowadays, owing to academic specialisation, students leave university or college under a bewildering array of categories. We now have bio-chemists, chemical engineers, metallurgical chemists, petroleum chemists, pharmaceutical chemists, tinctorial chemists, and many other kinds. It is possible that, in spite of premature specialisation, these graduates may have the essential qualifications of a chemist, but there is also the ever-increasing risk that chemistry may not have entered adequately into the mental make-up of such a student, in which case all his subsidiary studies in other branches of technology will not make him into a chemist, although sometimes they may enable him to acquire a chemist's job. Already this contingency is exercising the minds of many members of the two professional associations, because it is becoming apparent that unless the registration of *bona fide* chemists is speedily accomplished, chemistry as a clearly defined whole-time profession will cease to count in Great Britain.

There are many difficulties in the way, one being the matter of designation already mentioned, and another which arises from the diversity of circumstances in which chemists pursue their avocation. There are academic chemists in universities, colleges, and schools, chemists in the civil service and in the employment of local administrative authorities, chemists engaged either as employers or employees in chemical industry throughout its varied ramifications, and there are private consultants who serve the public directly as analysts, chemical advisers, forensic chemists,

and specialists in many other unclassifiable ways. In regard to these numerous categories, chemistry differs essentially from medicine and the law, and resembles more closely engineering, in which profession each addition to the scope of its practitioners is soon followed by the creation of a new institution of engineers.

The danger to the chemical profession of a similar fissiparous tendency renders registration the vital problem of the immediate future. The subject is being warmly discussed, and already acute differences of opinion on this burning topic are apparent even within the profession. Those in favour of registration for chemists will, however, derive encouragement and hope from the reflection that a similar battle of the giants was waged fifty years ago between the advocates of a new 'organisation of professional chemists' and the champions of the long-established Chemical Society.

Registration will not solve all the troubles of chemists, but it will benefit both them and the community by assisting to maintain to the fullest extent the high professional standard now reached after fifty years of combined effort.

Meteorology: Ancient and Modern.

Manual of Meteorology. Vol. 1: *Meteorology in History.* By Sir Napier Shaw, with the assistance of Elaine Austin. Pp. xx + 339 + 18 plates. (Cambridge: At the University Press, 1926.) 30s. net.

THIS is a most interesting book, and the name of the author, so well known to all students of meteorology, is a sufficient guarantee of its accuracy and pleasant style. The aim of the book is defined by the following quotation from the preface:

"The object of the book is to present the study of meteorology, not only as making use of nearly all the sciences and most of the arts, but also as a world study of a special and individual character, going back inevitably to the very dawn of history and beyond that to the mazes of geologic times."

Much information is given upon sundry subjects that are not strictly meteorological, but only incidental thereto, as, for example, the Kalendar and the causes of Equation of Time. The early chapters are devoted to the connexion of meteorology with European culture in primitive times. The part of the world best known to the ancients was confined to the shores and islands of the Mediterranean, and data are given concerning the

temperature, rainfall, and wind prevailing at the present day at twelve stations in that region. There are also many quotations from the poets and historians of Greece and Palestine. It is pointed out that Egypt, being dependent upon natural irrigation by the waters of the Nile, was in a different position from Greece and Palestine, where the failure of the rains might easily, and indeed often did, produce a famine.

The question of the source of the water of the rivers seems to have afforded ground for much conjecture to the Greeks; but apparently it was known to the Jews, if we may judge from a passage in Ecclesiastes: "All the rivers run into the sea, yet the sea is not full; unto the place whither the rivers go, thither they go again." It is also apparent from the tables relating to the Mediterranean area that the region is a dry one during the summer, many stations having no rain for three or four consecutive months.

From the heat of the summer and the copious supply of moisture afforded by the warm water of the sea, one would expect frequent thunderstorms and heavy rain, a climate, in fact, like that of the Doldrums; but, as Sir Napier explains, the latitude is that in which all the great deserts of the world are found, and but for the sea the region itself would also be a desert. The conditions produced by the general circulation of the atmosphere must therefore overpower the local conditions that are favourable to rain.

In Chapter vi. the variability of the Mediterranean climate in historical times is considered, and after carefully summing up the evidence, Sir Napier comes to the conclusion that "the seasons are the same and the crops are still mainly the same and require the same cycle of seasons, though the area over which they can be profitably cultivated may have been considerably reduced, and some of the region may have been transformed from habitable land into inhospitable desert."

The next chapter is on weather lore, and covers the time from Aristotle to the invention of the barometer. A translation is given of the well-known passage from Virgil in the first book of the "Georgics," containing instruction to husbandmen.

Chapter viii. contains seventy-four brief biographies of pioneers in the science of weather, the list consisting of the names of men who lived between the years 1561 and 1860 and were either meteorologists, designers of meteorological instruments, or makers of discoveries in physical science on which meteorology depends. It begins with Francis Bacon and ends with Angelo Secchi, an

Italian astronomer. The chapter includes a copy of Fitzroy's instructions for the use of a barometer to foretell the weather.

Chapter ix. is on meteorology as an international science, a subject on which Sir Napier's long service as president of the International Committee especially qualifies him to speak. For the purpose of forecasting weather, telegraphic information from neighbouring countries is required: each country has its own organisation and receives telegrams from a more extensive region than its own country covers. Naturally, therefore, many questions arise involving such matters as the units to be employed, the code to be used, the hours of observation, etc. These questions can only be settled by mutual agreement between the chiefs of the various meteorological services. The details of the different committees are given, and the necessity for further collaboration is emphasised. Observations, though greatly increased by the facilities afforded by radio telegraphy, are only available from well-populated districts, and on the sea from the lines of steamer traffic, and Sir Napier advocates the formation and maintenance of stations for purely meteorological purposes wheresoever they may be required. He also advocates an International Weather Office, that should be staffed with the most competent of meteorologists and physicists.

The following chapter deals with the surface air, and discusses without detail the instruments, self-recording and otherwise, that are commonly required in the meteorological observatory.

We then come to Chapter xi., which deals with the upper air. This chapter contains seventy-five very beautiful illustrations of cloud forms, with some remarks upon the classification of clouds, the measurement of their height and of their motion. The methods of observation of the upper wind by means of pilot balloons are described, so also are the meteorographs used with *ballons-sondes*. The chapter ends with two useful tables which give particulars of the type and cost of balloons, meteorographs, and accessories used by the various countries in obtaining a sounding to ten or more kilometres height.

The next chapter (xii.) is concerned with the study of the atmosphere, and consists largely of descriptions of instruments for measuring solar and terrestrial radiation and electrical forces. It is good to find the importance of radiation fully recognised in a volume on meteorology; it is undoubtedly one means by which heat flows in a vertical direction from layer to layer of air; yet

many writers ignore this, while others seem to ascribe the vertical distribution of temperature to it alone, which seems to the reviewer as far from the truth as is its entire neglect.

Radiation and dynamic heating and cooling are the only means that can produce a change of temperature in a mass of air above the level where the condensation of water vapour becomes negligible.

The author prefers to measure radiative energy in a dynamical unit and states that he finds kilowatts per square dekametre the most convenient. The more usual unit is a gram calorie per square centimetre per minute, but something may be said in favour of gram calories per day, since a gram calorie is more generally understood than a joule and the day is the natural meteorological unit.

Chapter xiii., which is on "The Development of Arithmetical and Graphical Manipulation," gives a description of the usual diagrams that one finds in books and papers on meteorology; it also explains and gives formulæ for obtaining various quantities, such as the standard deviation, the amplitude and phase angle of the terms in a Fourier's series, the method of searching for periodicities, and other similar quantities.

The explanations are very lucid and easy to follow; in fact, the chapter may be taken as a useful text-book on the commonly used statistical formulæ. As an illustration of the use of semi-logarithmic squared paper, the author gives a graph of his tephigram, a method which he has suggested for showing the data obtainable from the *ballon-sonde*. This graph is very useful, and a full explanation of its use is promised for Vol. 3.

Limitation of space forbids comment on Chaps. xiv. and xv. They are not wanting in interest, and are on "Air Movement into the General Circulation and the Cyclone" and on "Meteorological Theory in History."

The book, with the index, contains 339 pages, including 121 illustrations, numerous bibliographies, and references to original papers. It is excellently printed and will be read with pleasure by all those who are interested in any way in scientific matters. Meteorologists already owe a debt of gratitude to Sir Napier Shaw for his previous books, and their debt is greatly increased by this volume; they will look forward to the publication of the two succeeding parts, one of which is already in the press.

W. H. DINES.

Problems in Tropical Africa.

East Africa, a new Dominion: a Crucial Experiment in Tropical Development and its Significance to the British Empire. By Major Archibald Church. Pp. 315+12 plates. (London: H. F. and G. Witherby, 1927.) 18s. net.

TO students of tropical African development, this book may be commended as the earnest effort of an acute thinker to set out a problem and provide the answer to it. In his description of present-day conditions in that large group of East African territories, which vary as greatly in the character of their native inhabitants as in that of their geographical features, Major Church has been studiously fair-minded, and his treatment of local personalities and local policies will go far to undo the mischievous effects of the work on Kenya published three years ago by Dr. Norman Leys. Almost every page in the book raises questions of interest or points of controversy, and it is not possible within the limits of a short review to do more than select a few items for comment.

In the chapter upon development the author comments severely upon the neglect of water transport. On all the great lakes navigation has been maintained ever since these countries came under European control, but transport services cannot be maintained on a lavish scale without cargo to transport, and the presence of 'fly' and malaria near the lakes militates against native cultivation in their immediate vicinity where the ground is low-lying and fertile. The congestion on Victoria Nyanza witnessed by the author was a passing phase due to an increase in the Uganda cotton crop, for which the railway was not prepared that season. On the other hand, in considering river transport it should be noted that in Africa, as in India, great rivers like the Zambezi, with their alternating seasons of flood and drought, make it quite impossible to maintain trustworthy transport services by water; while on the Nile in Uganda in seasons of high water the river is dangerous to navigate on account of the floating sudd, and sometimes becomes blocked for months at a time. Only this last season the products of Bunyoro, dependent upon the Nile for outlet, were held up for some months on this account. Thus the present conditions of water transport are the outcome of practical experience; they cannot fairly be attributed to lack of imagination as suggested by the author.

In his proposals to introduce the methods adopted by the French in Madagascar to foster the

native cattle industry, Major Church has made no allowance for the resistance offered by pastoral tribes, and by the Masai in particular, to what amounts to a revolution in their regard for, and treatment of, their cattle from time immemorial, and yet we have in India an ever-present example of the difficulty of inducing a change in the mental attitude of ancient and backward races towards their cattle. Nor has he given the local governments credit for the efforts which they have been, and still are, making to wean some of the younger men from old tribal customs by teaching them modern methods of animal husbandry. Moreover, he seems to be unaware of the conditions under which the meat industry was established in Madagascar. What would be said by the political opponents of the existing government of Great Britain if they encouraged the local government to grant a monopoly in the trade to one of the international meat trusts, and lent them their support not only in procuring the meat in the colony, but also in its sale in the home country?

The most interesting proposal in the book is the suggestion that the system of government in these territories should be based upon 'community self-government,' each community, white, black, Arab, and Indian, raising its own taxes and disbursing them. Each territory would have its own legislative council, upon which each of the four communities would be represented, and eventually a central government would be set up with an elected house of representatives and a senate. Presumably the principle of community representation would be extended to these bodies also. Too little information is given to show how this 'model constitution' could be made to work in practice, and experienced administrators will probably rub their eyes as they read the all-too-short paragraph devoted to the subject. But, in fact, it is difficult to take the proposal seriously in view of the author's previous declaration in his chapter on the colour problem that he was "forced to the conclusion that the Whites must accept full responsibility for the government of the peoples of East Africa, and that any attempt to share it with the brown races will be disastrous in its consequences upon black and white races." How can the one statement be reconciled with the other?

A passing reference may be made to Major Church's comparison between the East Africa Committee set up by the late Secretary of State and the Joint East African Board. Whatever the merits of the former, and its personnel was certainly unexceptionable, it had all the defects

as well as the merits of a committee of experts appointed by a government to advise it. It would probably prevent some mistakes being made; it would also block progress. The latter body, whatever its demerits may be, has at least the democratic merit of being directly elected by those whom it serves, namely, the whole body of white people actively engaged in agricultural, commercial, and industrial pursuits throughout East Africa from the Zambezi to the Sudan border. It was in existence a year before the East Africa Committee was set up. It has already survived it by nearly three years.

However one may sympathise with the author's desire that the Mandates Commission of the League should apply the principle of trusteeship to the whole of tropical Africa, it would be well to bear in mind that the very existence of the League depends upon the goodwill of its members, and that the merest semblance of dictation will shatter its authority and dissolve its membership. It should not be forgotten that a *questionnaire* issued last year to the members of the League holding mandates was regarded as inquisitorial and excited strong protest from Australia in particular; while throughout the whole of East Africa at the present time there are grave misgivings regarding the disabilities of Tanganyika as a mandated territory. At this juncture any proposal to extend the scope of the mandate system would inevitably lead to a concrete demand to throw off our obligations under the existing mandate. This would certainly not serve the cause of the League of Nations.

While one may differ from the views of the author on particular points, one can close the book in whole-hearted agreement with his final conclusion as to the effects of white settlement on the native races. He says:

"It is my firm conviction that the natives in East Africa are far better treated than in any other part of Africa—except, perhaps, in parts of British West Africa—and that within a few years, through their more intimate contact with the white peoples, they will have progressed far more rapidly than the native communities in the West."

A few mistakes in the book may be noted. It is a pity that the name of the Kabaka of Uganda, Daudi Chwa, is incorrectly printed at the foot of his photograph facing page 30, as this young man is likely to figure more prominently in East African affairs in the future than he has in the past. On page 48 North-Western Rhodesia should read North-Eastern Rhodesia. The correction is import-

ant as the political future of Northern Rhodesia is somewhat uncertain, and a casual reference to this work might confuse the reader. A glance at any map will explain the point. At several points in the book reference is made to a "Chamber of Conventions." There is no such body in East Africa. The context shows that reference is intended to the Convention of Associations, that is, the periodical meeting in convention of the various white associations throughout the country. On page 151 reference is made to Brooke Washington as the author of "Up from Slavery." The writer of that most excellent book was, of course, the late Booker T. Washington.

The Unity of Life.

Plant Autographs and their Revelations. By Sir Jagadis Chunder Bose. Pp. xiv + 231. (London: Longmans, Green and Co., Ltd., 1927.) 7s. 6d. net.

PROPOS of the theme under review, it may be not without interest to mention at the outset that an eminent botanist, the late Sir Francis Darwin, in the course of his presidential address before the British Association in Dublin, so far back as 1908, formulated the opinion that "it is consistent with the doctrine of continuity that in all living things there is something psychic, and if we accept this point of view we must believe that in plants there exists a faint copy of what we know as consciousness in ourselves." Wherein resided this plant psyche, this faint copy of consciousness? Diffused throughout the cellular elements as in lowly organisms? Our views seemed nebulous; and yet why should they remain so? An oak-tree is as highly developed a representative of the vegetable world as one of the higher vertebrates is of the animal world. It seems in some measure strange that before now some one had not thought of trying to find out if any special system of plant-tissue had become established which showed definite association with psychic phenomena. We welcome, therefore, an attempt which has been made, through the researches of Sir J. C. Bose, to lift the mist which has so long enshrouded the analogous workings of plant and animal life.

In affording evidence that plants possess a 'heart' and circulatory system, and a 'nervous' system, Bose's researches bring into closer harmony the main phenomena of life in general. Herein lies the kernel of his theme, the key to the situation; and so our story becomes not only fascinating but

also supremely important. The establishment of a closer and at the same time a more rational kinship between plant and animal—a kinship which *a priori* we might expect to have existed from the beginning—clothes the author's theme with a special charm. His data (made possible largely through experiments which necessitated the use of wonderfully delicate and ingenious instruments) have resulted in such profoundly interesting findings that the expert plant-physiologist feels bound to question the values set upon material, technique, and experiment as a whole. We must look to experts for confirmation. Here is a theory at stake, something offered, too far-reaching in its nature to remain in abeyance. The 'Boseian' doctrine must stand or fall: experts will not allow the verdict to remain an open one. In the meantime, those of us who have not devised instruments delicate enough to measure, in millionths of an inch, the throbbing tissues of the plant; or other instruments which can amplify a movement by millions of times, for the purpose of following minutely the phenomena of plant-growth; or yet again, those of us who have not connected up and put to the test the delicate electric probe in circuit with the galvanometer, for the purpose of determining the localisation of nervous tissue, should hesitate to look altogether askance, on learning that plants have what may be regarded as a nervous system, and a pulsating action like that of a 'heart,' analogous to what are found in animals. The sceptic overmuch may find it profitable to reflect on the fact that it requires an amazing degree of amplification to record the responses of ordinary plants to stimulation. Indeed, in insisting upon strict analogy, it must be borne in mind that vegetable pulsations represent but a very faint copy of what takes place in the blood-vascular system of animals.

No doubt some biologists may reject Bose's views on the grounds of their being too extravagant. This is not altogether to be unexpected. Much of what the investigator has given us is so pronouncedly novel that the strongly conservative mind may find it most difficult to see other than phantasy and even wild conjecture! Here, however, it is noteworthy that if the plant be endowed with the power of telling us something about its doings, and if its own signature (a signed autograph, rendered possible through the medium of an exquisitely delicate instrument carrying a fine 'pen') be proved correct, this written evidence will surely militate against hasty and unproven indictments. We all know *Mimosa*—the sensitive plant—which closes its leaves when they are

touched. To most of us little more is known regarding vegetable sensitiveness. Sir J. C. Bose aims at demonstrating the universality of sensitiveness in the vegetable world. His book abounds with highly interesting 'graphs' representing responses to stimuli from without, mechanical, thermal, electrical, and chemical.

Again, it should be emphasised that the values attached to these 'autographs' demand the closest scrutiny of expert plant-physiologists. Meanwhile, it is not a difficult matter, nay, rather a pleasure, to recommend the book warmly and with a considerable degree of confidence. The text is couched in language which every one can follow, and from start to finish arrests attention. Certainly, the ordinary man who reads this book gains a fresh and broader outlook on life. If for a moment we presuppose that the Boseian doctrine failed to convince, and that it even fell back into obscurity, we can still feel a deep sense of gratitude to the author for giving us an opportunity of becoming cognisant with his fundamentally important views. It is pleasant to follow his patient researches, in which his skilfully devised technique (displaying minutiae in every detail) goes hand in hand with his experiments.

From a survey of the illustrations, which greatly enrich the pages of the work, we turn our attention to a perusal of the text. Here, were scientific facts not demonstrable, we would feel at times carried by the narrative almost into fairyland. Parts of the story savour of romance, the sequence of which is maintained in a charming style from chapter to chapter. The dumb plant, in its silent life, can be made to write an account of its own history, revealing its marvellous and varied behaviourism, which, in principle, coincides with that in animals. The plant sleeps and awakens with a rhythmic regularity: consequently it yields distinct variations of sensibility during different periods of the day. The script which the plant can be made to furnish explains clearly, among many other things, the varying effects of wounds upon its tissues, leaving finally as a legacy a faithful autograph of its many and varied forms of death-spasms.

Such is a mere passing glance at part of the synopsis of a fascinating story. For the rest, which recounts many other interesting aspects of plant-life, we must refer the reader to the book itself. But, having read the text through, we find that the author's views lead us to accept all the more fully that supremely important doctrine, namely, that *life is a unified whole*. To quote the author's

own words: "The barriers which seem to separate kindred phenomena will be found to have vanished, the plant and the animal appearing as a multiform unity in a single ocean of being." No dictum in philosophy is more acceptable to the thoughtful biologist.

C. J. PATTEN.

Our Bookshelf.

The Essential Oils. By Horace Finnmere. Pp. xv+880+11 plates. (London: Ernest Benn, Ltd., 1926.) 70s. net.

THERE are two ways in which an author may arrange the subject matter of a book such as that under notice—biological and chemical. Mr. Finnmere adopts the former method and is thereby committed to a plan which precludes any general discussion of the constitution, reactions, and relationships of the commoner constituents of essential oils, but permits of some account being given of the chemistry of the rarer substances such as diosphenol and ascaridole, each found in only one kind of essential oil. This is not a serious disadvantage, since every chemist probably has on his bookshelves, in these days, at least one textbook giving a good account of terpene chemistry.

Mr. Finnmere has, however, not taken full advantage of his own plan. He has arranged his material according to the natural orders of the plants from which essential oils are derived. It would have been easy to introduce each of these natural groups with an account of the kind of constituent found in and possibly peculiar to the oils of the group, but this has only been attempted in one sub-group, the eucalypts, and there probably only because such relationships have been thoroughly worked out for this genus, thanks to the admirable researches initiated and largely carried out by Baker and Smith at the Sydney Technological Museum. Introductory statements of the kind suggested would have directed attention to the need for similar investigations in other plant genera yielding essential oils.

There can be no question that these researches have been of great industrial value to Australia, and similar studies elsewhere might do something to bring about that closer association of science and industry which the author thinks is desirable in the interests of the development of this branch of the fine chemical industry within the Empire.

Mr. Finnmere is an assiduous collector and a careful and discriminating compiler. It is not an easy task to search the files of agricultural, commercial, technical, and scientific literature for the kind of information required to make a work of this description complete, and the author has clearly spared no pains to ensure this. As a result the book can be cordially recommended not only to the biological and chemical research worker, but also to the manufacturer and user of essential oils, as an authoritative and up-to-date account of this particularly interesting group of natural products.

T. A. H.

The Civilization of the South American Indians : with Special Reference to Magic and Religion. By Prof. Rafael Karsten. (The History of Civilization Series.) Pp. xxxii + 540. (London : Kegan Paul and Co., Ltd.; New York : Alfred A. Knopf, 1926.) 25s. net.

SOUTH American peoples have received inadequate attention from ethnologists, and the number of studies of their culture which are of substantial and permanent value is surprisingly small. On this ground alone, Dr. Karsten's book would be welcome as a record of observed fact; but in addition he is an original thinker whose work must receive consideration as a contribution to theory in social anthropology, whatever may be our ultimate judgment as to the validity of his conclusions when given extended application. In a preface contributed by Dr. E. Westermarck, this distinguished authority says: "Dr. Karsten's book is the most important contribution to the study of certain aspects of the South American native civilization which has yet appeared." The weight of this dictum is indeed increased by the fact that for some pages he then goes on to argue against views put forward by Dr. Karsten in criticism of his own conclusions.

The material contained in the book is the outcome of studies carried on during a stay in the Argentine and Bolivian Gran Chaco from 1911 until 1913, and among the tribes of eastern Ecuador from 1916 until 1919—five years which were devoted specially to the study of religious beliefs and practices. The starting-point of the investigation—and of the book—was the self-decorative practices of the Indians and their connexion with religious beliefs. By a natural transition the author passes on to the study of the bearing of ritual and beliefs, including ornamental art, spirits, magic, taboo, mana, beliefs relating to birth and conception, and the practice of *couvade*.

Interpolation. By Prof. J. F. Steffensen. Pp. ix + 248. (Baltimore, Md. : Williams and Wilkins Co.; London : Baillière, Tindall and Cox, 1927.) 36s. net.

THE theory of interpolation is a subject which has progressed more slowly than many other branches of mathematics, and the reason is not far to seek. A practical computer is sufficiently occupied in performing lengthy calculations and leaves the mathematician to provide the necessary equipment. The mathematician, when interested in interpolation-series expansions, looks primarily at the question as a branch of the theory of infinite series, which is of little use to a computer needing limits to the error involved after the first few terms.

At present a non-rigorous treatment dominates most text-books on interpolation. The earliest attempt to bring together those approximate formulæ which are simple enough to admit a remainder term giving limits to the error involved was made by Markoff in 1896. During the past thirty years, the number of formulæ with workable remainder terms has greatly increased, and the object of Prof. Steffensen in the book before us

is to give an account of the present state of the subject. The formulæ collected here will appeal mainly to actuaries and to computers engaged in calculations of the actuarial type. Prof. Steffensen has very successfully filled a real gap in the computer's library, although he impresses us with the fact that he has published a text-book, and not an encyclopædia on the subject.

Anatomy : Descriptive and Applied. By Henry Gray. Twenty-third edition, edited by Prof. Robert Howden. Notes on Applied Anatomy revised by John Clay and Dr. James Dunlop Lickley. Pp. xvi + 1400. (London : Longmans, Green and Co., Ltd., 1926.) 42s. net.

IT is just a century since the birth of Henry Gray, a brilliant anatomist who was elected a fellow of the Royal Society at the early age of twenty-five years, and in his thirtieth year published his text-book, "*Anatomy : Descriptive and Applied*," which after passing through twenty-three editions in the sixty-nine years of its existence is more popular than ever with students.

The success of the book was in large measure due to the excellence of the wood-engravings made for the original edition by Dr. H. Vandyke Carter. Their strength and clearness, their accuracy and insistence on essentials, made an irresistible appeal to students and simplified the process of learning. Prof. Howden is to be congratulated on maintaining the qualities that originally made this book's reputation, and for insisting, in a generation that is prone to be satisfied with half-tone blocks, on the continued use of wood-engraving as the only adequate means for illustrating text-books of anatomy.

The only criticism to be made of the twenty-third edition is to express regret that the section dealing with the central nervous system is not being kept abreast of the growth of knowledge and the needs of the clinician.

Le calcul des probabilités : son évolution mathématique et philosophique. Par Prof. L.-Gustave Du Pasquier. Pp. xxi + 304. (Paris : J. Hermann, 1926.) 49 francs.

THIS account of the mathematical theory of probability divides naturally into two parts. After a historical introduction the writer gives an account of the addition and multiplication of probabilities, probable errors, and Bernoulli's theorem. Elementary methods only are used in establishing or illustrating these classical results. The second and more valuable part opens with a fairly exhaustive account of the various interpretations of the calculus of probabilities and then proceeds to a critical analysis of its logical foundations. This investigation is interrupted by a chapter dealing with the applications of the theory of probabilities to physics, and then concludes with a rather diffuse account of a definition of probability resting upon the theory of aggregates. The aim of this work is to place the theory of probability on a satisfactory logical foundation, but this goal appears to recede into the distance as we advance towards it.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Distribution of Sizes among Rain-drops.

COL. GOLD's article in NATURE of April 30, p. 654, has prompted us to communicate the results of some observations which we have made of the size of rain-drops. The work has had to be discontinued for the moment, but possibly the results, incomplete as they are, may be useful to other workers in this field.

The accompanying diagram (Fig. 1) shows the distribution of sizes among 3026 rain-drops observed between Oct. 1924 and June 1925. The method of measurement was that described by us in the *Proc. of the Royal Dublin Society*, vol. 17, p. 1, 1922. The rain-drops measured by Defant (*Akad. Wiss. Wien, Sitzungsber.*, 114, 2a, p. 585, 1905) are for the most

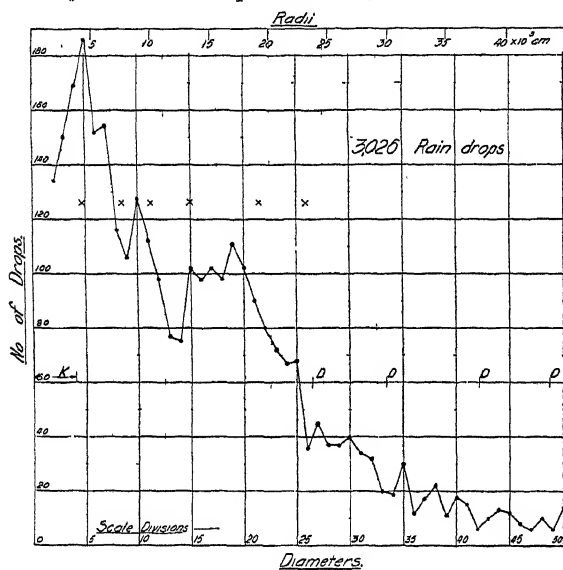


FIG. 1.

part larger than those observed by us. For the range in which our observations overlap, we have marked the sizes which Defant found of most frequent occurrence (D, D). The range of Kohler's observations on mist particles (*"Geofysiske Publikationer,"* vol. 2, No. 6, Kristiania, 1922) is also indicated on the left of the diagram (K).

It was suggested to us that the peaks on our curve of sizes might be due to the tendency, in measurements of this kind, for the readings to group themselves round the fives and tens of the scale employed. We therefore undertook a further series of measurements with a magnification about 1.8 times that previously employed. Observations on 909 drops gave a curve on which only one peak out of many coincided with a multiple of 5 scale divisions. Apart from the maximum at radius 4×10^{-3} cm., the general correspondence of the curves was not very satisfactory. The positions of the principal peaks on the second curve are indicated (X, X). It is evident that a great number of observations must be accumulated before definite conclusions can be arrived at.

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No. 3008, Vol. 119]

The Supposed Law of Flame Speeds.

ON behalf of my colleagues and myself, I desire to submit the following observations upon the letter from Dr. Payman and Prof. Wheeler on p. 779 of NATURE of May 28 about our recent experimental examination (*Proc. Roy. Soc., A*, 114, pp. 404-449) of their supposed 'law of flame-speeds.'

It is true that in a paper entitled "The Interpretation of the Law of Speeds" (*Trans. Chem. Soc.*, 123, pp. 412-420; 1923) Dr. Payman had explained that "the fact that the rate of reaction must also depend on the concentrations of the reacting gases results in small divergences from the law when the oxygen is in deficit," and that "the correction necessary to allow for this cannot be correctly estimated, but the general effect of this factor is to make the speeds of the uniform movement of flame in complex mixtures rather slower than the speeds calculated from the law of speeds." Such qualification—which was fully quoted and set forth in our Royal Society paper (*loc. cit.* p. 421)—implied only small divergences from the 'law,' that is, rather slower flame speeds than it would predict; but by no stretch of language can it be held to cover deviations of such magnitude as were discovered during the flame-speed tests described in our recent papers.

The statement that the principal hydrocarbon mixtures chosen for our blending tests were of acetylene or ethylene with oxygen, and that the choice was made because such mixtures are 'so sensitive' is incorrect, as will be seen from the following catalogue of the different pairs of primary mixtures (A and B) actually used in our blending tests:

A		B	Flame speeds, cm. per sec.
(1) 64.4 C_2H_2	35.4 O_2	and 83.1 H_2	15.4 O_2 1400
(2) 12.35 C_2H_4	87.5 O_2	and 38.7 H_2	61.2 O_2 2190
(3) 49.9 C_2H_4	49.9 O_2	and 92.5 H_2	7.4 O_2 180
(4) 55.45 C_2H_4	44.35 O_2	and 93.45 H_2	6.45 O_2 75
(5) 53.2 CH_4	46.5 O_2	and 92.9 H_2	7.0 O_2 115
(6) 11.05 CH_4	88.95 Air	and 71.9 H_2	28.1 Air 64
(7) 11.5 CH_4	88.5 Air	and 72.6 H_2	27.4 Air 51

Of these seven pairs of primary mixtures, only (1) and (2) can be regarded as in any way 'sensitive'; the remaining five (which, be it noted, showed the greatest deviations from the 'law') were certainly not so, as their quite moderate flame speeds indicate. Also, in the last three series of blending tests the hydrocarbon used was neither acetylene nor ethylene but methane; and in the last two the supporter of combustion was not oxygen but air. Indeed, the last three series of blending tests were made because Payman and Wheeler had declared that such complex methane-hydrogen-oxygen (or -air) mixtures obey the 'law.'

Readers of NATURE who may be specially interested in the subject will doubtless study for themselves the evidence contained in our paper, and we will leave them to form their own conclusions upon it. For those who have not time to do so, we need only say that, although the test applied to the 'law' in our experiments was the one prescribed by its authors, in not a single instance was the 'law' obeyed. Indeed, in all but one case (and that with the rather 'sensitive' acetylene-hydrogen-oxygen blendings), it broke down utterly.

Our conclusion against the general validity of the 'law' was chiefly based upon the following facts, which are in direct contradiction to it, namely:

(1) That when an acetylene-hydrogen-oxygen mixture of the composition $C_2H_2 + 2H_2 + O_2$ is exploded, neither carbon is deposited nor any appreciable

steam formed, all the hydrocarbon being burnt to carbonic oxide and hydrogen, leaving the original hydrogen intact.

(2) That in all the complex ethylene-hydrogen-oxygen or methane-hydrogen-oxygen (or -air) mixtures examined by us, which were formed by blending a hydrocarbon-oxygen (or -air) mixture (A) with a hydrogen-oxygen (or -air) mixture (B), both having the same flame speed and both containing oxygen in defect (*i.e.* the respective pairs of primary mixtures numbered 3 to 7 inclusive in the foregoing list) the effect of progressively increasing the proportion of (B) in the various blendings in each given series of tests was to lower the observed flame speed progressively until a point was reached when the resulting complex mixture no longer propagated flame at all.

The fact that the flame speeds for $(\text{CH}_4 + \text{H}_2)$ -air mixtures exhibit only small deviations from the supposed 'law' is scarcely relevant to the discussion because of the comparatively small proportion of a hydrogen-air mixture which has to be blended with a methane-air mixture of the same type and speed to produce a $(\text{CH}_4 + \text{H}_2)$ -air mixture containing oxygen in defect, the only condition that really matters. Thus, for example, in the case examined by us, only 13.35 volumes of a $71.9 \text{ H}_2/28.1$ -air mixture (flame speed = 64.1) would have had to be blended with 86.65 volumes of an $11.05 \text{ CH}_4/88.95$ -air mixture (flame speed = 64.5 cm. per sec.) to produce a $(\text{CH}_4 + \text{H}_2)$ -air mixture with a flame speed of 58 cm. per sec., that is, with a deviation of only 10 per cent. from that required by the 'law' (see Table V. on p. 439 of our paper). When, however, oxygen was substituted for air as the supporter of combustion, a much greater deviation was observed; for, as will be seen from Table IV., p. 437 of our paper, if a $53.2 \text{ CH}_4/46.5 \text{ O}_2$ mixture were to be blended with a $92.9 \text{ H}_2/7.0 \text{ O}_2$ mixture so as to form a $(\text{CH}_4 + \text{H}_2)$ -oxygen mixture, the speed of the two primary mixtures (each 114 cm. per sec.) would be lowered in the process to about 88 cm. per sec., or by about 23 per cent. Our experiments also indicated that a series of $(\text{CH}_4 + 2\text{H}_2)$ -oxygen (or -air) mixtures (oxygen being in defect) would show even more considerable deviations from the 'law.'

In conclusion, I would add that our experimental examination of the supposed 'law' was undertaken from a sense of duty, and that, having satisfied ourselves that it does not apply to gaseous explosions generally, it has no further interest for us. So, with more important matters to investigate, we do not propose continuing its discussion any further.

WILLIAM A. BONE.

Imperial College of Science,
South Kensington,
London, S.W.7,
June 3.

The Walrus.

ALTHOUGH the walrus is usually found near the land subsisting on the shell-fish it finds at the bottom, it is also on rare occasions found amongst the drift ice in deep water, far from land, subsisting on seals and other mammals.

A few examples of the latter kind are recorded in the log-books of whaling and sealing voyages to the Greenland Sea in my possession, and several others came under my own observation during voyages to the same locality.

On one occasion (July 1890), when amongst the ice, off the east coast of Greenland, I noticed an unusual number of birds, some oily water, and something floating in it. Lowering a boat, I found it to be a

dead narwhal. It was criss-crossed with deep wounds, had its abdomen ripped open and partly eaten away, and its viscera, including most of the liver, removed. It was only recently dead. Hidden from me and my companions in the boat by a high piece of ice, but visible from the mast-head of the ship a mile or two away, a large walrus lay asleep on an adjoining piece of ice. Unaware of this, and considering the narwhal—a female without a tusk—valueless, I returned on board empty-handed, to learn about the walrus and to be told by my father that the ship could no longer be delayed.

On an earlier voyage, before I commenced sailing with him, my father, the late Capt. Gray of Peterhead, came across a narwhal recently dead and a walrus engaged either in killing it or eating it. The facts will be found fully reported in *Land and Water*, December 1879. Briefly, in July 1879, in lat. 78° , long. 3° W. , amongst the ice between Greenland and Spitsbergen, my father noticed an unusual commotion in the water, and, on ascertaining the cause, lowered a boat and secured both the walrus and its victim. The body of the latter was scored with deep wounds, and the stomach of the former was packed with its blubber.

On another occasion (June 1887), in lat. 73° , long. 16° W. , we saw a walrus in the water with a seal in its mouth. Lowering a boat, we killed the walrus and retrieved the dead seal. The latter, a *floe-rat*, *Phoca hispida*, was almost cleft in twain by a single wound. On other occasions I have removed portions of seal (bits of skin, blubber and liver) from a walrus's stomach. (Particulars are to be found in the *Zoologist*, 1889, p. 8.)

The solitary animals that we used occasionally to find amongst the ice far from land subsisting in the way described were all of large size, and may well have belonged exclusively to the male sex. In the only two instances in which it is recorded the sex is male; none of them were accompanied by calves; moreover, in the summer months the adult males cling less to the land than the females and immature animals, venture farther afield, and are more likely to be seen far from land. In fact, the old 'bulls' are not to be found in the in-shore waters of Spitsbergen and Franz Joseph Land in June and July (see Allen, "North American Pinnipedia," p. 108, and *Zoologist*, 1895, p. 75).

In Scoresby's time straggling walruses were apparently more frequently seen by the whalers on the so-called 'whaling banks' between Greenland and Spitsbergen. In his "Arctic Regions," vol. 1, p. 508, we read of a single ship, while engaged in its quest for whales, picking up as many as half-a-dozen in a single season without approaching either Spitsbergen or Greenland with the express purpose of catching it. This may well have been the case, for it was not until a later date that the Norwegian walrus hunters began to kill them in the in-shore Spitsbergen waters and that it became seriously depleted in number.

R. W. GRAY.

11 Hulham Road,
Exmouth, Devon.

Surface Film of Aluminium.

IN NATURE of May 7, p. 673, I have read with a good deal of interest an account of some experiments made on aluminium foil which had been treated by the Bengough anodic process. In some experiments made on ordinary aluminium foil in connexion with a research on the determination of oxide in aluminium, details of which work was published in the *Jour. Soc. Chem. Ind.*, vol. 45, p. 170, the writer, in collaboration

with Miss H. E. Millar, had previously made the same observations as Messrs. Sutton and Willstrop. In our experiments, and employing the same method, it was even possible to notice the film on such thin foil as 0.00075 in. in thickness, and moreover we were able to identify surface markings on the layer which were originally present on the original metal. Messrs. Sutton and Willstrop are probably unaware that we had previously made this observation, and therefore the correctness of our conclusions becomes the more certain. W. H. WITHEY.

The National Physical Laboratory,
Teddington, Middlesex,
May 17.

WE are glad to have been given the opportunity of reading the letter from Mr. W. H. Withey. We had already read the paper by Mr. Withey and Miss Millar with much interest, and had spent a good deal of time in an attempt to interpret their results. These appeared to us to indicate that the material of their sheet No. 1 was free from both internal and superficial oxide; that rolling sheet 1 down from 0.01 to 0.006 in. in thickness produced a film thicker than that which we have so far found present on aluminium which has stood over long periods exposed to air, and that later rolling reduced the thickness of the film as well as that of the metal to a value much below the normal, assuming equal density of the films.

It appeared to us possible that under the very high pressure exerted by the rolls, the metal may attain a very high temperature locally and oxidise rapidly in the same way in which, for example, steel is known to do in an overloaded ball race, but that the oxide film formed in the early stages of rolling may obstruct further superficial oxidation during subsequent rolling. We do not know whether Miss Millar and Mr. Withey have any further results which would throw light on this matter or whether they would regard this tentative explanation as a reasonable one.

Accepting the results of Miss Millar and Mr. Withey regarding film formation in rolling, of which we have no experience, our experiments have so far indicated that by long standing in air, a surface film is formed of three to five times the thickness of that present on their finished sheet, but at present our experience has been confined to thin sheets. Also, the directly observed increase in weight of aluminium standing in air, recorded by Dr. Vernon in the second report to the Atmospheric Corrosion Research Committee, corresponds to about twice the thickness of film present on the finished sheet of Miss Millar and Mr. Withey, assuming the films to have the same composition.

H. SUTTON.
J. W. W. WILLSTROP.

Metallurgical Department,
Royal Aircraft Establishment,
S. Farnborough, Hants,
May 31.

Etch Planes in Metallic Single Crystals.

IT is well known that when an etching solution is applied to a metallic crystal, the action takes place so as to leave the surface 'stepped' in such a way that optical reflection takes place from planes in the crystal which are definitely related to the crystallographic axes. We have investigated this relationship with single crystals of iron, nickel, and aluminium.

The iron crystals were etched with a 10 per cent. solution of nitric acid in alcohol, and the nickel ones with concentrated ferric chloride solution. We have obtained very good etch patterns on aluminium by treating first in caustic soda and then with ferric

chloride solution. This process appeared to give a better contrast etch than the ordinary treatment with caustic soda alone.

The apparatus for locating the etch planes by means of the optical reflections consisted simply of a crystal goniometer mounted in place of the prism table on an autocollimating spectrometer. The planes from which reflection takes place can be identified by measuring the angles between different reflecting facets. By setting the crystal so that a zone axis is parallel to one of the goniometer axes, the angle between two reflecting planes can be measured by a single movement of the goniometer.

In the case of iron, which is a body-centred cube, the problem appears quite simple, the etch reflections being mutually perpendicular, indicating that the planes are {100}. (See also McKeehan, *NATURE*, May 14, p. 705.) The case of aluminium (face-centred cube) is similar, except that in a few cases reflections were obtainable from {110} planes. These reflections, however, were always very faint compared with those from {100} planes. Although the structures of aluminium and nickel are similar, they etch in different ways. Davisson and Germer (*NATURE*, April 16, p. 558) state that nickel crystals etched by vaporisation develop {111} facets. Using the etch method described above, we have found that {111} and {100} facets are formed, as is shown by the fact that strong reflections were obtained in directions inclined to one another at 90°, 70°, 55°, or the supplements of these angles.

A considerable number of crystals were examined by the optical method and the measured angles were generally within 1° of the calculated values. X-ray examination by Müller's method (*Proc. Roy. Soc.*, 105, p. 500) of a number of nickel crystals gave results in agreement with the optical data. The development of two etch planes does not in any way invalidate the use of etch reflections for the determination of crystal planes, but a more thorough examination of the crystal becomes necessary to avoid ambiguity.

H. H. POTTER.
W. SUCKSMITH.

Physics Department,
The University,
Bristol, May 20.

'Active' Nitrogen.

IN all the work, both theoretical and experimental, which has so far been done with regard to active nitrogen, it has at least tacitly been assumed (a) that active nitrogen is homogeneous and (b) that the afterglow and chemical activity are necessarily co-existent, although from Saha and Sur's theory of the nature of active nitrogen (*Phil. Mag.*, 118, 421; 1924), it follows that nitrogen may be 'active' and yet show no luminosity. Dr. H. W. B. Skinner has recently suggested to the author that in view of the production of H atoms, excited H₂, and H₃ by the discharge in hydrogen, it does not necessarily follow that the form of nitrogen which is responsible for the afterglow is that which is chemically active. Experimental evidence completely in support of this theory has now been obtained.

If a stream of glowing nitrogen be led through a second and weak discharge, the luminosity is destroyed or very considerably diminished, as described by Lord Rayleigh (*Proc. Roy. Soc.*, 92, 438; 1916). The concentration of active nitrogen in the gas stream may be determined by the admission of nitric oxide to the gas below the discharge (Willey and Rideal, *Jour. Chem. Soc.*, 1926, 1804), and it has now been found that when two independent discharges are provided, one

strong and producing the afterglow and the other feeble, the gas being led from the former to the latter, the yield of nitrogen peroxide is *greater* with the two discharges than when the stronger is used alone, in spite of the almost complete extinction of the glow by the weaker discharge. Moreover, if the latter be used alone, little or no luminosity is visible in the gas in the exhaust line, but abundant formation of nitrogen peroxide occurs.

It thus appears that the glowing and chemically active forms of nitrogen are distinct from each other, and that the estimates as to the energy of 'active' nitrogen made severally by spectroscopists and Dr. Rideal and myself have really been upon different modifications of this element. The same applies to the respective deductions as to the nature of 'active' nitrogen. While we may now with confidence regard the luminous variety as being due to the recombination of atoms with a heat of formation of ca. 250,000 cal./gm. mol., the nature of the other kind, which is apparently the chief constituent of 'active' nitrogen and possesses an energy of ca. 45,000 cal./gm. mol. is still somewhat obscure; the choice would appear to lie between metastable molecular nitrogen and a more complex body such as N_2 .

A full account of these investigations will shortly be published.

E. J. B. WILLEY.

Laboratory of Physical Chemistry,
Cambridge, May 4.

Designation of Thyroxine.

KENDALL (*Proc. Am. Physiol. Soc., Am. Jour. Physiol.*, 45, 540; 1918) named the crystalline compound he isolated from the thyroid *thyroxin*, as an abbreviation for *thyro-oxy-indole*, since he believed it to contain an indole nucleus. Harington has shown that, on the other hand, it is an iodised amino-acid, derived from tyrosine. He has gracefully accepted Kendall's name, merely adding the final *e* necessary for an amino-acid in English terminology.

Nevertheless, from a teaching point of view, a name that signifies something incorrect is undesirable, in spite of numerous examples that persist (the majority of bio-catalysts do not produce a 'boiling' and do not occur in yeast, and are but clumsily, therefore, termed ferments or enzymes; it is doubtful if the majority of 'hormones' 'arouse').

It seems very desirable that Harington, or, if he refuse, some one of the elder endocrinologists, should find a new name for this internal secretion of the thyroid gland which will more accurately suggest its derivation. I would suggest for their consideration a term such as *thyrosine*, or *thyroisine*, either of which practically retains Kendall's name, and at the same time emphasises both the thyroid origin of the compound and its close relationship with tyrosine, the two points which obviously require emphasis.

May I also suggest that stress should be laid on Harington's opinion (*Biochem. Jour.*, 20, 298; 1926). "In view of the constitution of thyroxine . . . racemisation during the alkaline hydrolysis (of thyroid tissue) is the probable explanation of the absence of optical activity in the product." It seems, by analogy, extremely unlikely that thyroxine, as secreted by the thyroid gland, should be optically inactive; and further, by comparison with adrenaline, we may reasonably infer that one of the two optically active isomers will be physiologically completely, or almost completely, inert. If this should prove to be the case, then commercial thyroxine will have but one-half the activity of thyroxine in thyroid, and an explanation may be available for that discrepancy between the physiological activities of thyroxine and

of desiccated thyroid tissue that Reid Hunt found by use of his acetonitrile test with mice (*Am. Jour. Physiol.*, 63, 257; 1923); my own experiments, utilising growth and organ-hypertrophy effects on rats (*Trans. Roy. Soc. Canada*, 20, 307; 1926) have supported his conclusion that (*optically inactive*) thyroxine does not represent the full activity of the thyroid gland.

A. T. CAMERON.

University of Manitoba,

Winnipeg, Canada, May 25.

The Calibration of Photographic Plates.

IN NATURE (May 14, p. 707) Dr. E. A. Baker discusses the calibration curves of photographic plates. The curves he gives certainly show a good agreement in sensitivity between the different batches of plates used under his conditions of standardisation. Concerning the reference to Harvard results (Harvard Circular 302), it may be of interest to note several points not fully discussed in the original paper on spectrophotometric method.

The curves to which Dr. Baker refers are the density curves of ten of the photographic plates analysed in our regular photometric programme, and are representative of the general results obtained. Inter-comparison of the curves allows us to examine the effects of emulsion and developer. Curves for plates taken from the same box show no closer agreement among themselves than do those for different boxes of plates coated with the same emulsion. Even plates with two different emulsions show no greater differences from one another than do plates with the same emulsion.

A similar result is obtained with regard to developer. Plates developed with different batches of one developer agree as well as do those from a single batch of developer, while plates developed with one of the two kinds of developer used at Harvard show an agreement among themselves that is little, if any, closer than the agreement for plates developed with the two different kinds of developer.

The idea of the Harvard individual plate calibration curves, however, was not specifically the elimination of differences in emulsion or developer, though this will of course follow. It was to set up a density curve for the plate used, *for the conditions under which it was exposed*, rather than to ensure the constant sensitivity of different plates under carefully standardised conditions. The calibration curves, as described in Harvard Circular 301, will allow for any possible changes in sensitivity due to the temperature and humidity during exposure in the telescope, to the ageing of the plates, or to delayed development, as well as for any loss of transparency of the background and exposed portions of the plate due to sky fog.

Exact agreement between various reduction curves is not to be expected, nor would it have any significance for the spectrophotometric results. Individual plate calibration is at least a safe procedure until such time as a greater knowledge of, and dependence on, the actions of photographic plates under various conditions is obtainable.

FRANK S. HOGG.

CECILIA H. PAYNE.

Harvard College Observatory,

Cambridge, Massachusetts, June 3.

The Spectrum of Ionised Neon ($Ne II$).

FOR some time the spectrum of ionised neon ($Ne II$) has been a subject of investigation in the Amsterdam Laboratory "Physica." The analysis of the F I spectrum, given in former papers (*Verslagen Kon. Acad. Amsterdam*, June 1926; December 1926)

and the theory of complex spectra of Heisenberg and Hund formed preliminary steps for the analysis of Ne II. A great part of the Ne II lines have now been classified by me in a term scheme exhibiting a perfect analogy to that of F I. The following table gives an example of this analogy:

F I.				Ne II.							
Term.	<i>j</i> .	Term Value.	Term Difference.	Term.	<i>j</i> .	Term Value.	Term Difference.	Hund's Theory.	Interval Ratio.		
									Landé.	F I.	Ne II.
a^2P	2 1	135320 134913 (16.6 volt)	407	a^2P	2 1	270000 269220 (33.4 volt)	[780]	$^3P + 2_2$			
4P	3 2 1	58617.0 58342.3 58182.3	274.7 160.0	4P	3 2 1	117000.0 116482.0 116183.0	518.0 299.0	$^3P + 3_1$	1.67	1.72	1.73
$^4P'$	3 2 1	45104.8 44981.9 44879.2	122.9 102.7	$^4P'$	3 2 1	89938.2 89715.6 89533.1	222.6 182.5	$^3P + 3_2$	1.67	1.19	1.21
4D	4 3 2 1	44035.4 43858.8 43714.3 43630.9	176.7 144.5 83.4	4D	4 3 2 1	87022.7 86684.9 86435.2 86291.1	337.8 249.7 144.1	$^3P + 3_2$	2.33 1.67	2.11 1.73	2.34 1.73
4S	2	42595.0		4S	2	83178.0		$^3P + 3_2$			

The complete term table for Ne II and the lists of classified lines with further details will be published elsewhere.

T. L. DE BRUIN.

Laboratory "Physica,"
Amsterdam, May 24.

The Nomenclature of Chromosome Groups.

It is well known that several plants and animals have been found which have (a) three, four, or more haploid groups of chromosomes, instead of the usual two. These groups are typically identical, not only in the number, but also in the nature of their members; thus being homologous groups. On the other hand (b), in certain genera, species, or subspecies, have been found the haploid number of chromosomes of which is two, three, or four, etc., times that of the half number of a basic species in the same genus. In typical cases of this kind these extra chromosomes are not homologous, or not completely homologous, with those of the basic group.

Now in the first case (a), the words diploid, triploid, and tetraploid have been some time in use. It would be scarcely possible, in the writer's opinion, to change the application of the word 'diploid,' for example, and confine its use to case b, as has been lately suggested (O. F. I. Langlet, *Svensk Bot. Tidskr.*, vol. 21, pp. 1-17; 1927). The cytologists who are doing such praiseworthy work in counting the chromosomes in different genera are not compelled to make use of a Greek terminology already employed in a different sense. They may have recourse to the mother tongue, and the terms, *single*, *double*, *triple*, *quadruple* . . . *multiple*, convey no necessary implication of homology, and would hence suit case b. Or, if technical terms are wanted, they are at hand in the Latin, where *uniplex*, *duplex*, *triplex*, *quadruplex* . . . *multiplex*, await application to case b.

JOHN BELLING.

Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor, Long Island. N.Y.,
May 27.

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Absorption Bands of Liquid and Vapour Amines.

By measuring, below wave-length 4μ , the absorption of secondary and tertiary solid and liquid amines, it was shown that the N-H bond has a strong characteristic absorption band around 3μ (*Proc. U.S.*

Nat. Acad. Sci., 12, 74; 1926). It seemed, from the data on various substances by other workers, that this was an overtone of a fundamental at 6μ .

Measurements, with a rock-salt prism spectrometer, of the absorption of longer waves by liquid and vapour amines, have recently been made here. They show a weak 6μ band both for secondary and tertiary amines, so that this band cannot be taken as the fundamental of the 3μ N-H, the latter being, then, a fundamental.

This is in harmony with the recent results of Ellis for aniline liquids, whose very accurate measurements below 2.8μ showed a series of overtones characteristic of N-H, the calculated fundamental of the series extrapolating to 2.8μ , not to 6μ (*J. Am. Chem. Soc.*, 49, 347; 1927).

E. O. SALANT.

Physics Department, Johns Hopkins University,
Baltimore, Maryland, U.S.A.,
May 19.

Unauthorised Publication of the "Grammar of Science."

MESSRS. STECHERT AND Co., of New York, have issued, entirely without my sanction, a reprint of the last edition of my "Grammar of Science." Copies of the book have been recently sold in England. I should like to inform possible purchasers, through the columns of NATURE, that the book is unauthorised and can only be sold illegally in Great Britain.

Messrs. Stechert & Co. kindly inform me, having regard to the issue of a new and revised edition, that "it is better"—they do not say for whom—"to have the book constantly on the market." It is needless to add that the "Grammar of Science" in its last edition, without a thorough revision, is not a book such as I should wish to issue under my name; it is not abreast of the recent advances in physical science and epistemology.

This is not the place to comment on the morality of American copyright law.

KARL PEARSON.

University College,
London, W.C.1.

Some Recent Services of Metallurgy to Engineering.¹

By Prof. H. C. H. CARPENTER, F.R.S.

IN honouring me with the invitation to deliver the James Forrest lecture this year—the thirty-third of the series—the Council of this Institution expressed a desire that I should deal with recent advances in metallurgy which have a bearing on engineering practice. It is twenty-one years since my distinguished predecessor Sir Robert Hadfield delivered the last lecture in which metallurgy constituted the main subject, and it would seem convenient, therefore, that I should deal with the progress made since that date.

FLOTATION.

As regards ore-treatment, water-concentration is eminently satisfactory in the concentration of ore containing relatively coarse and granular mineral and a light gangue. Chemical treatment is equally satisfactory when the valuable mineral crushes to powder and the gangue is not soluble. Between these two lies the field of flotation, this method of concentration being effective both in the presence of a heavy gangue and a fine mineral. It belongs to the present era of mining, which dates back to the exploitation of the rich auriferous gravels of California and Australia about the middle of the nineteenth century, though the first flotation process to be applied commercially was that developed by Elmore in London in 1898. He was, moreover, the first to apply the selective action of oil to a pulp flowing freely from a wet-crushing machine. Put briefly, in flotation the mineral is floated on an air froth, while the gangue sinks to the bottom, whereas in concentration the mineral sinks to the bottom and the gangue is floated away.

There are three main types of froth-flotation machines, known respectively as the mechanical, pneumatic, and cascade. Of these the mechanical flotation machine is the widest applied. The standard pattern machine has a capacity of about 1.25 tons per square foot of machine area per day. A machine of ordinary size will treat about 400 tons per day, and require about 100 H.P.

Flotation first established itself by the recovery of lead and zinc-blende from an association with heavy gangue at Broken Hill, New South Wales, its success being complete about 1910. Whereas with water concentration, before the advent of flotation, the recovery was only 60 per cent. of lead, less of silver, and none of the zinc, the recoveries to-day are about 85 per cent. of the lead, 65 per cent. of the silver, and 83 per cent. of the zinc. These percentages do not include the lead in the zinc concentrate, or the zinc in the lead concentrate. The cost of flotation is about 6s. per ton, and that of complete dressing about 9s. per ton. At the Butte, Superior, Montana, the present recovery is about 92 per cent. from an ore assaying about 17 per cent. of zinc, flotation being

responsible for about three-quarters of the production.

At Anaconda, where in 1915 the recovery of copper by water was 78 per cent., a flotation equipment was erected in the expectancy of raising the recovery to more than 90 per cent. This expectation has been realised. At Utah-Leasing, Newhouse, Utah, a tailing dump containing about 700,000 tons, assaying about 0.7 per cent. of copper, was successfully treated by flotation, the concentrate assaying about 18 per cent., and the final tailing about 0.2 per cent. At Calumet and Hecla at Lake Superior, a conglomerate of ore containing native copper is treated by a flotation plant having a capacity of about 2000 tons per day. From this material, which contains less than 1 per cent. of copper, a recovery of 60 per cent. is made at a cost of about 10d. per ton.

To-day, in fact, flotation is applied on practically every important non-ferrous mining field. Tin alone has not yet benefited by it. In general terms, where formerly water concentration yielded a 65 per cent. to 70 per cent. recovery, the adoption of flotation has raised the recovery to from 80 to 85 per cent.

REVERBERATORY FURNACE SMELTING.

As the finely divided concentrate cannot be smelted in a blast furnace, one of the principal consequences of the development of the flotation process has been the necessity of designing a new type of furnace. This has been developed from the original small reverberatory furnace, used many years ago in copper smelting in Swansea. The modern furnace, however, is so much larger and its method of working so different that the process is really a new one.² The fuel used in the modern large reverberatory furnace is pulverised coal or fuel-oil, depending upon the relative cheapness of the two fuels. When pulverised coal is used, it is ground so that 80 to 90 per cent. will pass a 200-mesh screen, and is blown into the furnace with about 15-oz. air pressure. The coal used may vary in ash content from 6 to 7 per cent. up to as high as from 15 to 20 per cent., without giving trouble. The ratio of charge to fuel varies from 5 to 7½ : 1. The burners are inserted directly in the rear wall of the furnace, and several are used, from four to six being the usual number. The type of burner varies in each plant with apparently equally satisfactory results.

When using fuel-oil in the furnaces it is generally from 17 to 19 Bé., and is preheated to about 200° F. to 250° F. before burning, as this results in fuel economy. When as much heat as possible has been extracted from the gases, they are passed through waste-heat boilers for a further recovery. These are from 500 B.H.P. to 750 B.H.P., and are frequently connected to a common cross flue,

¹ From the thirty-third James Forrest Lecture delivered before the Institution of Civil Engineers on May 3.

² Liddell, "Handbook of Non-Ferrous Metallurgy," vol. 2, pp. 948-951.

extending from all the reverberatory furnaces, so that in case of a shutdown of a furnace the boiler capacity will not be lost; and if a boiler is down for cleaning or repair, the other boilers are available for the utilisation of the waste heat. It has been found advisable to have the flues from the furnaces to the boilers sloping slightly towards the furnaces, as otherwise trouble may be experienced from the accumulation of slag.

The reverberatory furnace is the most satisfactory apparatus in which to treat fine ores, but it usually requires an extensive roasting plant, occupies a large amount of space, and locks up a large amount of valuable metal. Hence the investment is large for a given tonnage.

LEACHING.

Copper has been extracted from its ores by heap-leaching methods in Spain since 1752, but these contain from 2 to 3 per cent. of metal. With modern methods it is economically possible to treat ores containing much smaller quantities of copper. In the spring of 1923 the Ohio Copper Company of Utah commenced the leaching of an ore which averages only 0.3 per cent. of copper. This has since proved to be a profitable undertaking. It consists of a copper-bearing quartzite, in which the copper minerals exist principally in the fissures. The quartzite is practically inert to chemical action, while the copper minerals are readily attacked by the leaching solution. At the Calumet and Hecla mine, an old tailing containing only 6 lb. of copper per ton (0.27 per cent.) has been successfully treated by an ammonia process. It has been estimated that about 15 per cent. of the copper output of the world is now produced by leaching, and two of the largest of such plants in operation at the present time produce copper at a considerably lower cost than by any other method of treatment. The leaching of copper and silver ores is now in a similar position to that of gold and silver cyanidation, and, especially in the case of copper ores, the process and plant used have followed very closely those employed for cyanide work. Since 1905, processes for the wet extraction of zinc and lead have been developed, and will probably in a few years become formidable rivals to smelting methods. Already the wet metallurgy of zinc is of considerable economic importance. Lead leaching at the moment has not attained so favourable a position as copper and zinc, and there is room for much further research in this direction.

REFINING.

Twenty years ago the manufacture of steel in the electric furnace was still in the embryonic stage. To-day more than 1200 such furnaces are in operation in Europe and America (including Canada), in about equal numbers in the two continents. In the decade 1910-20 the development of what may be called 'electric steel' has been astonishing. It increased from 52,141 tons in 1910 to 502,152 tons in 1920. In 1925, 1,042,000 tons were produced, of which the U.S.A. was responsible for 615,000, Italy 129,000, Germany 127,000, France

68,000, and Great Britain 44,000. The principal use of such furnaces has been in producing alloy and tool-steel ingots and castings. The first advantage of the electric furnace is its flexibility; the second consists in the method of applying the heat; and the third lies in the quality of the product. The outstanding disadvantage of the electric process is its cost. It may be expected that, with the continued improvement in efficiency of power-production plants, this disadvantage will tend to become less and less. Another factor which will operate in the same direction will be that economies in furnace operation will be more thoroughly understood and practised. Another disadvantage, from which the furnace has suffered more or less hitherto, is that it has been operated by men unfamiliar with its possibilities. To some extent the view has prevailed that electric steel occupies a field midway between acid and basic open-hearth steel and crucible steel. This is not the case. The quality of electric steel is fully equal to that of crucible steel, and can be achieved provided that refining is properly carried out metallurgically. If the electric steel is manufactured with care and the metallurgical treatment is correct, none of the five classes of non-metallic impurities (of which products from the reaction between dissolved and suspended oxides and gas and deoxidisers, and oxides not acted upon by deoxidisers, are the most important) ought to be present in more than small amounts. Except for small amounts of manganese sulphide and silicate, electric steel should, in fact, be free from non-metallic inclusions when melted with restricted or with no oxidation. Even when melted with complete oxidation, if it is deoxidised thoroughly it should still be cleaner than basic open-hearth steel.

Oberhoffer and Beutell³ have shown that in a very large number of open-hearth steels the gas dissolved averaged from 13-130 c.c. per 100 grams of metal. The gas contained about 75 per cent. carbon monoxide, the rest being hydrogen, nitrogen, and a small amount of carbon dioxide. Steel metallurgists have paid far too little attention to the presence of gas in steel and to the effect on its quality, but it has been proved that the content nitrogen reduces the tensile strength, and still more the ductility. In the open-hearth process the atmosphere with which the metal is in contact contains oxygen, nitrogen, hydrogen, and carbon monoxide. In the electric process, on the other hand, the amounts of oxygen, hydrogen, and nitrogen should be very much less, and the only gas that should be present in any quantity is carbon monoxide. Even this will only occur in small amounts, as furnace gases containing oxygen are absent. Precise figures as to the amounts of gas actually present in electrically-made steel are, however, still lacking.

'PEARLITE' CAST IRON.

One of the outstanding advances of the last twenty years has been the practical use of the

³ *Stahl und Eisen*, 1919, vol. 39, pp. 1584-90.

equilibrium diagram in the scientific manufacture of industrial metals and alloys. So important has this aspect of metallurgy become that in 1920 a society was founded in the U.S.A. known as the American Society for Steel Treating, for the purpose of improving the scientific manufacture of metals. This society has to-day a membership of 3500.

High-carbon iron carbon alloys solidify 'white' unless a particular stimulus is present to cause the precipitation of graphite. They consist accordingly of cementite and pearlite. Since 'white' iron is so hard as to render it incapable of being machined, its use is greatly restricted in mechanical engineering work. The addition of silicon, however, causes the formation of free carbon from such a white iron, and it is possible in certain favourable conditions, including slow cooling, to produce a cast iron consisting only of silico-ferrite and foliated coarse graphite. Such a material is very weak, although soft, and apart from a few special cases, such iron is but little used for mechanical engineering work. Between these two limiting conditions come the usual technical kinds of grey iron. The microstructure depends on the smelting and casting processes used, the conditions of solidification and cooling after casting, and upon the chemical composition. The rate of cooling is, of course, considerably affected by the cross-sectional area of the particular casting. In the microstructure of ordinary grey iron are usually found together varying quantities of graphite, silico-ferrite, pearlite, free cementite, and the phosphide eutectic, with inclusions of iron and/or manganese sulphide.

A carbon steel containing 0.9 per cent. of carbon consists, when annealed, of eutectoid pearlite only, the structure being uniform and dense. This material is pure steel. It has, as is well known, very remarkable mechanical properties. The problem of improving the qualities of cast-iron consists essentially in preparing a material composed mainly of pearlite with deposited graphite. A cast iron of this kind would certainly be superior in properties to any of the ordinary varieties, and it might be expected to exhibit mechanical properties approximating to those of pearlite steel, which would be influenced only by the graphite. Numerous tests carried out by different investigators on castings approximating to the above structure bear out this view. It was at first not found possible to get the desired structure in current practice. Diefenthaler and Sipp were, however, able to devise a process to enable this structure to be obtained regularly. It was patented in 1916. It has been improved upon, and has finally led to very definite rules for achieving the desired properties.

The properties found in the cast iron are: (1) High transverse and tensile strengths and toughness; (2) high resistance to impact stresses; (3) moderate hardness when properly treated; (4) only a slight tendency to the formation of 'pipes' and hence the possibility of making complicated castings; (5) great resistance to sliding friction (abrasion); and (6) fine and dense structure which is unaffected by temperature changes.

SORBITIC STEEL.

Steel wire ropes, after passing through the 'patenting process,' which consists in heating to a temperature at which steel scales, and then cooling more or less rapidly through the critical points, contain large quantities of 'sorbite' readily detected by the microscope after etching, or by the dark colour that the whole surface assumes when etched side by side with the rod before patenting. The property of enabling the patented rod to be drawn to a much greater fineness than is possible in the unpatented material is due to the effect of the sorbite present. Stead and Richards⁴ concluded that if sorbite is responsible for the excellent qualities of oil-quenched steel and negatively quenched steel wire rods, there is no reason why it should not be produced in steel rails, tires, etc., without great expense. With this object in view they experimented on 5-foot lengths, subjecting them to a variety of treatment.

Although the results of these experiments were decidedly promising, they were not able satisfactorily to treat a normal 30-foot length of rail. In all cases the distortion of the longer lengths was so considerable that their process never became a commercial success. The practical problem of treating the full lengths satisfactorily has been solved by Messrs. Sandberg so as to produce sorbitic structure. They realised that the right temper in the rail could be obtained in the course of one single operation if the correct rate of cooling through the critical range of temperature was secured. The precise range depends upon the composition of the steel. Their experiments using air-cooling were so encouraging that they were soon able to treat full-length rails of heavy section. The results obtained made it perfectly clear that their process could be carried out without interfering in any way with the output of the rail mills and at a comparatively low expenditure. The first rails treated were tramway rails, and gaugings taken from these after they had been one year in the track under very severe traffic showed that their life would be about 100 per cent. longer than that of the Sandberg high silicon rails of the same composition but untreated and laid at the same time in the same track. Plants for the Sandberg treatment of rails were put down by the Bethlehem Steel Company at their Sparrow Point Works, where trials were carried out and excellent results obtained. Shortly afterwards another plant was put down at the Dowlais Works of Messrs. Guest, Keen and Nettlefold, while a number of trial orders have been carried out on rails for various home railways.

The tensile strength of rails has frequently been raised from about 55 tons per square inch untreated to 65 and 70 tons per square inch after treatment, and even higher, without showing any signs of brittleness. Treated rails have, in fact, stood up to twice and even three times their specified falling weight test without breaking. The Brinell tests also clearly show that the process does not merely

⁴ *Journal of the Iron and Steel Institute*, 1903.

give a surface hardening, but that the treatment effect is produced throughout the head. The increased resistance to shock is due to the peculiar fineness of the structure of sorbite, which also gives smaller surface particles for tearing away by abrasion, and thus greatly reduces the wear in service. From careful observation under severe traffic conditions it has been found that treated rails have given double the life of untreated rails, and in some cases even better results have been obtained.

HIGH-SPEED TOOL STEELS.⁵

The revolutionary feature wherein tools made of these steels differ and exceed in service the tools formerly used, is their ability to maintain a sharp, strong cutting edge while heated to a temperature far above that which would at once destroy the cutting ability of a simple steel tool. A high-speed tool can be made to cut continuously at speeds from three to five times as great as that practicable with other tools and even when, as the result of the friction of the chip on the tool, it may be red hot at the point on top where the chip rubs hardest, and the chip itself may, by its friction on the tool and the internal work done on it by upsetting it, be heated to a blue heat of about 300° C. or even hotter. Accordingly these tools have in the past twenty years worked a remarkable revolution in the machine-shop business of the whole world, affording largely increased outputs and commensurately lower costs. As a consequence they are now used very generally, and in some shops almost exclusively, for machining iron and steel as well as some other metals by cutting operations by machine tools.

The property of red hardness, or ability to retain hardness at a red heat, may be imparted to steels of suitable composition containing chromium, tungsten and vanadium and, in the most recent tools, cobalt as well, by a unique heat treatment to which they are subjected. This is the Taylor-White process⁶ introduced at the works of the Bethlehem Steel Company in 1899. Tools thus treated were shown at the Paris Exhibition in 1900.

In the early days, after a good deal of experiment, the composition settled down to a basic one of about 14 per cent. of tungsten with from 3 to 4 per cent. of chromium. The next step was to introduce still greater percentages of tungsten and also to add vanadium. A class of steel has now been on the market for some time containing about 18 per cent. of tungsten, 4 per cent. of chromium, and anything up to 2 per cent. of vanadium. This class appears to have justified itself as indicated by the wide demand for it. The latest development came comparatively recently with the addition of cobalt (from 2 to 6 per cent.). These steels have also taken their place and found a market. In some steels molybdenum is added as well as the above four alloy elements.

The cutting edge of a rapid tool at work is prob-

ably never so hot as the metal which is behind it, where the heating caused by the friction of the chip as it is deflected and rubs hard on the tool is most intense. The edge itself is kept relatively cool by the cold metal flowing upon it. It is not generally realised that the point of the tool does not cut, and that it only drives open the crack which advances in front of it. A high-speed tool fails through the turning, which impinges on the top face of the tool, wearing away the steel until the cutting edge is actually broken off.

MUMETAL.⁷

The first commercial application of high-frequency melting in Europe was made by a British firm for the preparation of nickel-iron alloys for submarine cables. The research work pursued in order to find a suitable alloy was thereby much facilitated, and quickly resulted in the perfection of the series of alloys known under the name of 'mumetal' (so called because the Greek letter μ is used as the symbol of permeability). These alloys have highly desirable characteristics, and by their use the speed of cabling can be increased seven to eightfold.

A typical mumetal alloy has the following composition:

Nickel	74.0 per cent.
Iron	20.0 "
Copper	5.3 "
Manganese	0.7 "

An alloy of this composition has a magnetic permeability of 7000. Low hysteresis loss with a very high permeability at low magnetising forces are the characteristics chiefly required in these metals.

The composition of the mumetal may be varied according to the type of cable which it is proposed to use, and the annealing may be adjusted to give either (a) maximum neutral permeability, (b) maximum permeability at magnetic saturation, or (c) high or low fields for magnetic saturation.

The range of alloys developed for this class of work contains from 75 per cent. to about 50 per cent. of nickel, with percentages of iron varying from 20 to 25, and certain quantities of copper and manganese, but in every case freedom from carbon is one of the primary essentials, and for this reason the high-frequency furnace has proved the only suitable melting equipment.

In certain types of cable an increase in electrical resistance of the alloys is desirable, and in this case an extra element, which may be tungsten, chromium, silicon, vanadium, titanium, molybdenum, or aluminium, may be added in small quantities.

ANTI-CORROSION METHODS.

Aluminium is ordinarily covered with a protective film of oxide or hydroxide. It does not, however, constitute a perfect protection in the presence of corrosive liquids and even neutral salt solutions. It tends to crack and lose its power of adhesion

⁵ Hibbard, "Manufacture and Uses of Alloy Steels."

⁶ Taylor, F. W., "On the Art of Cutting Tools," *Trans. Am. Soc. Mech. Eng.*, vol. 28 (1908), pp. 31-350.

⁷ Campbell, *Journal of the Iron and Steel Institute*, vol. 112, p. 74.

to the metallic surface. Local corrosion (pitting) then sets in. Moreover, this film is much more liable to crack when subjected to alternate wetting and drying, particularly at an air-liquid interface. Probably the interfacial tensions of metal, air, and water operate in producing this result. The practical problem therefore consists in finding a method of forming a strong and tightly adherent film of oxide or hydroxide instead of the thin film. Mott⁸ showed that such a hydroxide film could be formed by making the metal the anode in a bath of sodium hydrogen phosphate, and recommended this treatment as a protection against corrosion. Working for the Corrosion Research Committee of the Institute of Metals, and with the aid of financial assistance from the Department of Scientific and Industrial Research, Dr. Bengough and Mr. J. M. Stuart, during the years 1921-24, carried out a series of investigations starting from this point, and found that the film produced by 'anodic oxidation' in a bath containing a chromate, bichromate or, best of all, chromic acid, protects the metal much more effectively against corrosion.

The process is carried out as follows: "After

⁸ Mott, "Electrochemical Industry," 1904, 2, p. 129.

thoroughly cleaning the surface of the aluminium or its alloy, it is immersed in a suitable bath, e.g. dilute chromic acid, along with a carbon rod; a small external electromotive force is applied so as to make the aluminium the anode and the carbon the cathode. The applied electromotive force is gradually raised to a value depending on the nature of the alloy and on the composition of the bath. Thus with duralumin in a chromic bath the voltage may be safely raised to 50 volts. After treating for some time in this manner, the surface of the metal becomes covered with a semi-opaque uniform white coating. This seems to consist almost entirely of aluminium hydroxide in a glassy adherent form. The hydroxide is possibly hydrated to some extent, but the hydration cannot be much, since the coating can be heated to at least 350° C. without changing in appearance or density."

The laboratory investigations were followed by successful experiments on a larger scale at the Royal Aircraft Establishment at Farnborough, by agreement with the Air Ministry, and the process, which is protected by patent, is now being worked in Great Britain by several firms on non-exclusive licences from the Department of Scientific and Industrial Research.

Organography of Plants.¹

A 'FESTSCHRIFT' celebrating the seventieth birthday of Dr. Karl von Goebel, professor of botany in the University of Munich, was published in 1925 as a special volume of *Flora*. It was initiated by an international committee including many of his colleagues, pupils, and friends: it comprises thirty-eight memoirs on the most varied botanical topics, and these themselves bear witness to the catholicity of the interests of the veteran whose birthday they celebrate. His election in 1926 as a foreign member of the Royal Society has marked the recognition in Great Britain of his great scientific career, happily by no means ended, though it has reached the prescribed span of life. These events followed closely upon the completion of the second and greatly enlarged edition of his "Organographie der Pflanzen." The interest which they have aroused among botanists is readily understood, for the name of von Goebel is intimately associated with an essential change of scientific outlook upon the organisation of plants. This has lately been made more than ever apparent in a volume from his own pen, written in celebration of the centenary of the birth of his teacher, Hofmeister, a translation of which into English was lately published by the Ray Society, and reviewed in *NATURE* (Oct. 2, 1926, p. 473). This essay reveals with a truly philosophic touch the genius of the master, while it serves also as a natural guide to any appre-

ciation of the life-work of the pupil, von Goebel himself.

In the early part of the nineteenth century a stiff and artificial nature-philosophy was still dominant. This was clearly incompatible with those evolutionary views which were then forming themselves in men's minds. Even before "The Origin of Species" was published, a change of outlook had been initiated. Hofmeister's keen insight had tracked down, and his pencil had recorded in detail, facts relating to Archegoniate plants, which more than any others were at that time essential for any consecutive evolutionary scheme for the plant kingdom as a whole. These facts were stated by Hofmeister with a breadth of view which allowed of their ready application later in terms of adaptation to environment. He was not merely an observer of stark structure, but he broached the subject of causal morphology, a branch of study then only nascent, but great with the promise of the future.

It has been the happy lot of von Goebel as his pupil to carry on the torch which Hofmeister had thus placed in his hands, and to deliver it with ever-increasing glow to a later generation. Morphology in his hands has taken a more rational place than was possible before. Under the title of "Organography,"—a word already used by Sachs in 1882, from whom also von Goebel will have drawn stimulus and guidance in the years of his assistantship in Würzburg—he has embodied in two stately volumes a wealth of fact treated comparatively, experimentally and developmentally, and related throughout to function. While maintaining the Hofmeisterian tradition of exactitude, he has promoted the living aspect already so

¹ 1. "Organographie der Pflanzen," Dr. K. Goebel. Zweite Auflage. (Jena: Fischer, 1913-1923.)

2. "Die Entfaltungsbewegungen der Pflanzen." Ergänzungsband zur Organographie der Pflanzen. (Jena: Fischer, 1924.)

3. "Festschrift zum siebenzigsten Geburtstage von Karl von Goebel, in München." (Jena: Fischer, 1925.)

4. "Morphologische und biologische Studien." Von Prof. Dr. K. von Goebel. *Ann. Jard. Bot. de Buitenzorg*, 36. (Leyden, 1926.)

prominent a feature in Hofmeister's later writings. The first edition of von Goebel's great work was translated into English, and published as one of the botanical series issued by the Oxford Press (1900-1905). The second German edition, completed in 1923, may be held as embodying the mature views of its author: at the same time it reflects the attitude of modern morphology, in which form is not divorced from the study of function as it used to be.

The closing volume, styled "Ergänzungsband zur Organographie der Pflanzen," was published in 1924: it relates to the movements of development of plants, and their teleological meaning. While the author at once notes that erroneous teleological interpretations have frequently been enunciated in the past, and points out how movements may exist to which no useful end can be ascribed, he boldly accepts legitimate teleological interpretations. He asserts that organography is in itself the discussion of the relations that exist between morphology and teleology, and he quotes from Asa Gray the passage: "Let us recognise Darwin's great service to natural science in bringing back to it Teleology: so that instead of Morphology versus Teleology we shall have Morphology wedded to Teleology." The broad sweep of this volume, the variety of the facts adduced, and the wide quotations of literature, often varied in origin and remote in time, impress the mind with the catholicity of interest of its author. It fully justifies an incident that occurred long ago at an international meeting of botanists, where an unusual plant presented a puzzle to us all, and some one said, "Ask Goebel." The question was not put to him in vain.

To British students of botany the name of Goebel will have first become familiar through the publication of a translation of his "Systematik" under the title "Outlines of Classification and Special Morphology of Plants" (Oxford Press, 1887). It was in fact a new edition of Book II. of Sachs' text-book. But, earlier still, the young professor of Rostock had profoundly impressed those of us who followed the German botanical literature by his writings in the *Botanische Zeitung*, and elsewhere. Much of this early work was summed up in his "Vergleichende Entwicklungsgeschichte der Pflanzenorgane," included in Schenck's "Handbuch der Botanik" (vol. 3, 1884). Here, with the true Hofmeisterian touch, he uses ontogenetic details as an avenue to comparative conclusions. In his hands the story of floral development, traced in skilfully selected examples, furnished a living commentary upon the dryer facts of Eichler, and rendered them into terms more closely related to the life of the organism. On the other hand, his comparative studies of the development of the sporangium might at first sight appear as mere *tours de force* of developmental observation. But they worked out naturally into questions of the widest evolutionary interest. In the 'eighties we soon found ourselves reaching out towards some ultimate point of view as to the real nature of the sporangium of land-living

plants: whether it is a part *sui generis*, or the result of some transformation of a pre-existent part, as the older morphologists had held. Or we entered deeply into the cell-cleavages which precede the definition of the sporogenous cells, in a study which lent precision to knowledge of development, but left us there in a manner stranded. In either case we were brought face to face with far-reaching questions of ancestry and origin, which even the subsequent disclosure of the fossils of the Rhynie Chert have not fully resolved.

As an administrator von Goebel has taken his full share of duty. The head of a large institute and garden, he has passed through his hands a stream of pupils drawn from many nations. Since 1889 he has edited *Flora*; and the pages of that great journal not only witness to his own activity, but also show the variety and quality of the work of his school. But it would be vain to attempt here to follow this indefatigable worker through all the activities of a long and busy life. The mere list of his publications as given in the 'Festschrift' runs to nearly two hundred titles, many of them books. It is more to the point here to refer to one of his latest works, published since his seventieth birthday. Travelling recently to Java, as he wrote in a private letter "once more to see the tropics," he did not go as a mere spectator, but as a worker. A volume of two hundred pages with sixteen plates, entitled "Morphologische und biologische Studien," is the result. In it he canvasses questions ranging from the lichens to the flowering plants. Specially characteristic is the memoir on the relations of certain Javanese ferns; for here von Goebel selects some which are well known as presenting systematic problems, and helps materially towards their solution. It is inevitable in such work that differences of opinion should arise. But here there need be no apprehension; for when von Goebel differs, he lays all his cards upon the table, and after expressing his own opinion he will adorn the difference with a quotation from the classics, or it may be with a humorous touch which leaves the social field unscathed, while the scientific arena is as open as before for friendly rejoinder.

It will be gathered by those who know von Goebel only by name that we see in him a very impressive figure: the bearer of a great tradition from the past, who through a long life has amplified and extended it. More than any other writer of the time he has saved plant-morphology from itself, by diverting its higher pursuit from formal and scholastic channels, and leading its adherents by preference towards middle lines of thought. This tends to promote the general advance much more effectively than any narrow specialism. Unfortunately the mental effort involved in the pursuit of some circumscribed theme is much less than that entailed by more generalised study. It is this that is apt to exercise an undue influence on those who desire to achieve immediate results, an attraction always resisted by von Goebel.

F. O. B.

Obituary.

DR. E. S. HARTLAND.

DR. EDWIN SIDNEY HARTLAND, the elder son of the Rev. E. J. Hartland, Congregational minister, was born at Islington in 1848. He joined the legal profession when a youth and practised as a solicitor at Swansea from 1871 to 1890. He was the first Clerk to the Swansea School Board and throughout his life devoted much of his time to further Welsh education, being much interested in educational matters in Wales and also in Public Libraries. In 1890 he was appointed Registrar of the County Court at Gloucester, and District Registrar of the High Court, and afterwards was appointed District Probate Registrar. Here he continued to act as a public-spirited citizen and gave especial attention to education. He was an alderman and mayor of Gloucester, chairman of the City Education Committee, of the Board of Governors of the secondary schools, and of the Public Library and Museum Committee. In the spring of 1924 a grave illness compelled him to resign all his public duties, and thereafter he was debarred from all physical and mental exertion. During the years he was bed-ridden he was always unrepining and cheerful and retained his sense of humour. The end came peacefully on June 19. He is survived by his widow, one son, and two daughters.

In recognition of Hartland's contribution to the study of folklore the degree of LL.D. was conferred on him by the University of St. Andrews in 1917, and that of Lit.D. by the University of Wales at Bangor in 1924. He presided over the Anthropological Section of the British Association at York in 1906, and over the Section of the Religions of the Lower Cultures of the International Congress of the History of Religions held at Oxford in 1908. He delivered the first Frazer Lecture at Oxford in 1922, and was awarded the Huxley medal by the Royal Anthropological Institute in 1923, but was prevented by ill-health from delivering the Huxley Lecture.

When one remembers the busy life Hartland spent in public duties it is surprising what an amount of literary work he accomplished. He was an early member of the Folk-Lore Society, and for many years was a contributor of articles and reviews to the journal of the Society, also as member of the council and as president of that Society, and, in continually helping other students by his crudition, he did a very great deal to establish folklore as a serious study. Folklore for Hartland was not merely the collection of curious superstitions and odd usages and rites, but he sought for their interpretation by an extensive and intensive study of anthropological literature, as is well exemplified in his great work, "The Legend of Perseus" (1894-96), and in "Primitive Paternity" (1909-10) and "Ritual and Belief" (1914). In addition to many papers in folklore, anthropological, and archaeological journals published in Britain and elsewhere, Hartland wrote some important articles for the "Encyclopædia of Religion and Ethics," and in various other ways he did what he could to

spread an interest in the anthropological aspect of the survivals of belief and custom found among civilised peoples. He was interested in the problems connected with matrilineal and patrilineal kinship, and in the relations of magic and religion.

It will be evident that Hartland studied a wide range of subjects, to all of which he brought to bear a mind trained in the value of evidence and a sympathetic, kindly nature. His writings are marked by a pleasing, lucid style with occasional lighter touches. He was a typical representative of the British school of anthropologists of the latter part of the nineteenth century. He often took an independent line and regarded "criticism as a form of co-operation in the pursuit of truth," but in criticism and debate was always tolerant and friendly. His place in the history of anthropology is assured. Few of his contemporaries now remain, but to them he will be remembered as a genial and constant friend who was always ready to receive and impart information. A complete list of his writings will be published in an early issue of *Folk-Lore*.

A. C. HADDON.

DR. IRVING BARDSHAR CRANDALL, a member of the technical staff of the Bell Telephone Laboratories and an authority on the telephonic transmission of speech and methods of recording it, died on April 22, at the age of thirty-six years. Dr. Crandall was born in Chattanooga, Tenn., on May 27, 1890, and graduated from the University of Wisconsin in 1909, later he studied at Princeton, and in 1916, three years after he had become associated with the Bell Telephone Laboratories, he received his doctorate from Princeton. At the time of his death, Dr. Crandall was engaged on important experiments. He recently published a book, "Sound and Vibrating Systems," and he had previously written monographs on the scientific aspects of speech, analyses of its mechanisms, and methods for recording it.

We regret to announce the following deaths:

Prof. Gustave André, professor of agricultural chemistry at the Institut National Agronomique, Paris, who contributed to our knowledge of plant absorption and assimilation of elements from the soil, on May 14, aged seventy years.

Surgeon-General Henry Cook, I.M.S. (ret'd.), formerly principal and professor of medicine and hygiene at Grant Medical College, Bombay, and dean of the Faculty of Medicine in the University of Bombay, on May 30, aged ninety-five years.

Father William F. Rigge, for many years director of the observatory of Creighton University, Omaha, who was known for his work on eclipses and eclipse maps, on Mar. 31, aged sixty-nine years.

Dr. G. von Tschemak, emeritus professor of mineralogy and petrography in the University of Vienna, aged ninety-one years.

Dr. Anton Wassmuth, formerly professor of mathematical physics in the University of Graz, aged eighty-two years.

News and Views.

A CASE of considerable interest to owners of land, to entomologists, and to public health authorities, has recently been heard in the Sheriff Court of Paisley. The pursuers, the Committee of the Upper District of the County of Renfrew, craved the Court to find that there exists upon the lands of Muirend, in the Parish of Cathcart, a nuisance within the meaning of the Public Health (Scotland) Act, 1897, in that certain ditches are so overgrown with vegetation that the flow of water therein is impeded and they have become breeding-places for mosquitoes. Complaints were received from a considerable number of residents in the houses within about five hundred yards of the Muirend estate that they had suffered severely as the results of mosquito bites, medical treatment having been rendered necessary in a number of cases. The pursuers therefore held that the ditches are "in such a state as to be a nuisance, or injurious or dangerous to health," and they craved that the defender (the owner of the land) should be required to clean out the ditches and to do such other things as may be required for the removal of the nuisance complained of. The mosquito in question is *Anopheles bifurcatus*.

THE defender's reply to the petition is that the existence of mosquitoes does not constitute a nuisance in the sense of the Public Health Act, and also that the bed of the stream a short distance beyond his property has been raised, thus causing damming back of the water. The inquiry lasted four days, and expert witnesses were heard on various aspects of the problem—engineering, entomological, medical, and legal. Sheriff Hamilton has decided in favour of the District Committee. He finds that the ditches have become so encumbered with silt and vegetation as to be ineffective as watercourses; that the ditches and the adjacent overflowed ground have become a breeding-ground for large quantities of mosquitoes; that mosquitoes from the area in question have invaded the residential district and attacked the inhabitants, and by their bites caused pain and swelling, occasioning in some cases temporary incapacity; that the presence of mosquitoes caused reasonable apprehension and diminution of comfort in the community; and that there is a reasonable probability of a repetition of these conditions in the following years. The Sheriff ordains the defender to clear the ditches of the silt and vegetation with which they are encumbered, and thereafter to maintain them clear of silt and vegetable growth. The case is of special interest as being the first of its kind under the Public Health Acts in Great Britain.

THE opening by Lord Onslow of the new Reptile House at the Zoological Gardens in Regent's Park, London, on June 15, marks an important stage in the development of the exhibition of living animals. The extraordinary appeal which the overhead lighting of the Aquarium made to the eye of the public ensured that this method would be extended to other types of

exhibits, and a first experiment in this direction was made at the Scottish Zoological Park, where, a little more than a year ago, there were opened to the public a tropical bird house and a reptile house with natural surroundings, in which daylight falls upon the inmates while the spectator is shielded from the direct rays. The new Reptile House at the London Zoo develops still further the ideas of concentrating attention upon the animals and of suggesting in the enclosures themselves the type of surroundings in which the various creatures naturally dwell. The technical experiments and artistic conceptions of the curator, Miss Joan Procter, have combined to give most successful results. In the larger enclosures the natural surroundings of the foreground are very effectively carried away into the distance by suitably designed backgrounds painted, for endurance, with motor-car enamels; vita-glass permits the access of the most beneficial of the sun's rays; and the compartments are fitted with elaborate electric installations for heating and lighting. Many of the creatures exhibited are themselves of the greatest interest: the seven-foot, yet immature, 'dragons' of Kermode are shown alive for the first time in Europe; but the scheme of the Reptile House adds enormously to the attractiveness and to the instructional value of the exhibits. The new house bids fair to catch the public fancy as completely as the Aquarium has done.

THE Royal Society of Edinburgh, like many another learned society, is concerned at the increasing volume of material offered for publication, and at the inroads which the publication of work of first-rate quality is making upon its resources. Its *Transactions* and *Proceedings* are very largely financed by the contributions of its fellows, with modest assistance from a Government grant and occasional help from the Government fund allocated by the Royal Society of London. Already the fellows have contributed a special Reserve Fund of £1100, but it is evident that if further provision cannot be made, scientific contributions of undoubted merit must be rejected, solely on financial grounds. An attempt to meet the difficulty is being made by the creation of a Publications Fund, to which the Council has already allocated sums amounting to more than £2000, and for which, it is hoped, further gifts will be earmarked in due course by fellows and others interested in this vital branch of the Society's activities. Papers submitted to the Society are already stringently 'refereed,' but the increasing claims made upon all publishing societies suggest that if publishing is to keep pace with production radical changes must take place in the form in which results are presented, so that while the main lines of investigation and the finished conclusions appear in scientific journals, the masses of detail and data, which at present occupy so much space, may be eliminated and yet be made available for consultation by scientific workers by being stored in manuscript form in recognised and specified scientific libraries.

AN exhibition designed to show the practical applications of recent scientific research work in the woollen and worsted industries was opened by Lord Novar in the Royal Scottish Museum, Edinburgh, on June 16. Lord Novar pointed to the need of closer co-operation between manufacturer and sheep-master, so that the latter might be aware of the exact requirements as regards grade and quality demanded for manufacturing purposes, with the view of breeding towards well-defined standards in these respects. He also indicated the important part research, conducted on scientific lines, has taken and is likely to take in furthering the aims both of breeder and manufacturer. The exhibits, which have been arranged by the British Research Association for the Woollen and Worsted Industries, cover a wide range, from samples of wool illustrating the characteristic qualities of various breeds of sheep and of some of their crosses, to delicate apparatus designed for the examination of spindles in rapid motion, for the testing of moisture content, elasticity, resistance to strain, etc., an ultra-violet radiation lamp by which faults of contamination may be readily detected, and a series of finished products illustrating common defects of manufacture and the methods by which they may be eliminated. The exhibition shows the purely scientific as well as the practical side of the work of the Research Association, which is to be congratulated on the great progress it has made and on its initiative in bringing to the notice of the public and the specialist these particular developments of scientific research.

AN exhibit of outstanding historical importance has just been added to the national collection at the Science Museum, South Kensington, through the generosity of Sir Charles Parsons and the directors of the Parsons Marine Steam Turbine Co., Ltd., who have presented to the nation the machinery and a portion of the hull of the epoch-making steam yacht *Turbinia*. This vessel ranks in historic interest with Patrick Miller's boat of 1788, Bell's *Comet* of 1812, and Pettit Smith's *Archimedes* of 1840, and no more suitable place for her could be found than in the museum which already possesses Symington's engine for Miller's boat and the engine of the *Comet*. The Parsons Marine Steam Turbine Co., Ltd., was formed in 1894 to test the application of the steam turbine—which had been in use ashore for ten years—to the propulsion of vessels, and the *Turbinia* was their experimental craft. Of 44½ tons displacement, 100 ft. long, her machinery developed no less than 2000 H.P. and gave her a speed of 34½ knots, or four knots faster than any other vessel of her day. Her performances at Spithead during the Diamond Jubilee review astonished the whole Navy. Though the majority of steam vessels afloat are still fitted with reciprocating engines, steam turbines are used in practically all high-speed vessels, in the majority of liners, and without exception in battleships, cruisers, and destroyers. The *Turbinia*, indeed, led directly to the *Hoods* and *Mauritanias*, and as such marks an epoch in the development of marine engineering second to none in importance.

PROF. GEORGE A. GIBSON, who has just resigned from the chair of mathematics in the University of Glasgow, was born at Greenlaw, Berwickshire, in 1858. He received his mathematical education at Glasgow under Prof. Jack and Lord Kelvin, and at Berlin under Kronecker and Weierstrass. From 1883 until 1895 he acted as assistant and lecturer in mathematics in the University of Glasgow. During that period he originated and conducted numerous special courses of lectures for honours students on advanced mathematical subjects, both pure and applied. In 1895 he was appointed to the chair of mathematics in the Royal Technical College, Glasgow, and in 1909 was recalled to the University as professor of mathematics. In the eighteen years during which he has held the chair, he has been to his staff an example of devotion to duty and to his students a great teacher. As the source and centre of a school of mathematics in Glasgow, he has expanded the scope and raised the standard of mathematical study in the University, fostered original research, and stimulated and encouraged the publication of many treatises on higher mathematics. Prof. Gibson has himself made valuable contributions to the theory of Fourier series and to other mathematical subjects. He is an authority on the history of mathematics, and has written important memoirs on famous Scottish mathematicians. He is the author of several well-known text-books, his "Treatise on the Calculus" being a standard work used throughout the British Empire. Prof. Gibson has always taken a keen interest in secondary education, and has rendered valuable services to the teaching of elementary mathematics in Scotland. He has been a conspicuous figure in the history of the Edinburgh Mathematical Society, and in 1902 he was elected an honorary member in recognition of his services and of his eminence as a mathematician. From 1917 until 1920 he held the office of vice-president of the Royal Society of Edinburgh, and in 1905 the University of Edinburgh conferred on him the degree of LL.D.

FOR some time past the problem of providing more adequate accommodation at Bedford College, London, for the greatly increased number of students, has been receiving attention. The present buildings were intended for 450 students only, while the College contains now 600. Six years ago, as a temporary measure, a new chemical laboratory was constructed out of old army huts. While never really adequate for their purpose, these relieved the more immediate pressure in one department but did not touch the growing needs elsewhere: they are now at the end of their life, and replacement before they are overtaken by complete dissolution has become urgent. It was decided to erect a new permanent building to meet the present needs, and the first step towards the materialisation of this project was taken on June 9 when Princess Mary, Viscountess Lascelles, visited Bedford College in the afternoon and laid the foundation-stone of the new wing. The existing science departments form the two wings of an open quadrangle, and it is proposed that the new extension shall

occupy a position to the south-west to join on to these and so form the fourth side of an enclosed quadrangle of about 150 feet by 120 feet. The total cost of the scheme is estimated at not less than £110,000, towards which there is in hand approximately £53,000. Beyond this limit it is impossible for the College to raise further sums from its own resources, and an appeal is therefore being made to the public for aid. The new building is designed to provide a laboratory of inorganic and physical chemistry in place of the army huts, a lecture-hall to accommodate 600 persons, a department for geography, additional space for physics, zoology, history, French, etc., and also much-needed additional students' cloak-rooms. On the roof there will be a small astronomical observatory. After the ceremony of laying the foundation-stone, Sir Hildred Carlile, president of the Extension Fund, made a statement as to the documents to be placed under the stone. These latter included a current copy of the *Times*, the College Calendar, coins of the realm, and other contemporary objects. After the ceremony, Her Royal Highness visited some of the science departments, the library, and the residence wing.

LAST week Corpus Christi College, Cambridge, celebrated the two hundred and fiftieth anniversary of the birth of the Rev. Stephen Hales, who was born in 1671, died in 1761, and was buried in the south transept of Westminster Abbey. In an appreciation of Hales in the *Times* of June 17, Dr. Monckton Copeman refers to Hales as one of the most remarkable of the many distinguished men that Corpus has produced. For fifty years Hales was perpetual curate of Teddington, and it was there he wrote his "Vegetable Statics" of 1727. His portrait is given in Schuster and Shipley's "Britain's Heritage of Science." A fellow of the Royal Society, a foreign member of the Paris Academy of Sciences, and one of the enthusiastic supporters of the Society of Arts, Hales' scientific work took a practical turn, and he was instrumental in improving the ventilation of ships and prisons, his work on which entitles him to be called a public health pioneer.

THE *Chemiker-Zeitung* of June 4 contains an interesting account of the thirty-second annual conference of the Bunsen Society for applied physical chemistry, which was held in Dresden on May 26-29, under the presidency of Dr. Mittasch of Ludwigshafen. In recent years it has been customary to make a special study of a particular branch of the subject, the theme chosen for this year being electro-chemical problems. Papers were read dealing with a variety of topics, e.g. electrical insulators, the corrosion of metals, the passivity of metals in alkaline media, the electrolytic separation of magnesium from complex fluorides, the influence of adsorbed ions on the sensitiveness to light of silver bromide, electrolytic processes in the alkali industry, etc. Prof. Billiter, of Vienna, in dealing at some length with the electrolysis of sodium chloride, pointed out that chlorine, instead of being a by-

product of the manufacture of caustic alkali, has recently become more valuable than the latter, owing to its application, particularly in Italy, to the manufacture of cellulose.

IN a pamphlet issued by the English Electric Co. describing electric locomotives for every-day haulage work in factories, a strong case is made out for their wider adoption. At the present time when wages are high and fuel is dear, any saving effected in either has a marked influence on production costs. In many works steam locomotives are used. Before the locomotive goes into service, steam has to be raised, necessitating the attendance of a fireman. The bunkers have to be filled and water must be taken on board. During service, consumption of fuel continues even when the locomotive is not usefully employed. In the majority of cases this standby loss is considerable. After service the fires have to be drawn and the ashes cleared away. Repairs and renewals are frequent, and during this time the locomotive represents capital lying idle. On the other hand, the electric locomotive is immediately ready for use, there are no standby losses, and it needs little attention. It will also for short periods sustain a heavy overload, and thus the rated horsepower of the locomotive may be much less than when steam is used. In general two electric vehicles can supersede three steam locomotives. The electric power is obtained either from self-contained batteries or from an overhead line, the latter method being as a rule the more economical. As all modern works have some kind of electric supply available, there seems no reason why electric traction should not be more widely used.

THE seismograms of the great Chinese earthquake of May 22, obtained at nine observatories in North America and at Honolulu, have recently been studied by Commander N. H. Heck (*Science Service News Bulletin*). He places its epicentre in lat. 35° N., long. 100° E. or some distance to the west of the position given in our previous note (*NATURE*, June 4, p. 826), and still farther to the west of that of the great earthquake of Dec. 16, 1920. It thus lies either in western China or eastern Tibet. It is worthy of notice that the faults in this district have a general east-and-west direction. No details of the earthquake have yet reached us, but it will be remembered that three months elapsed before the outside world knew of the earthquake of 1920, in which about a hundred thousand lives were lost.

THE International Union of Geodesy and Geophysics has published volume 3 of the Proceedings of the Section of Geodesy at the meeting of the Union held at Madrid in October 1924. This bulky volume consists of the reports on the geodetic work of various countries adhering to the Union. These reports, which are mainly in French and English, were presented to the meeting and are now bound together for convenience of reference. For the most part they cover work done between 1922, the date of the previous meeting at Rome, and 1924, but a few con-

tributions include additional papers such as one by Mr. J. H. Cole, of the Survey of Egypt, on errors in spirit levelling, another on changes of levels caused by the Japanese earthquake of 1923. The volume embraces reports from the chief European States except Great Britain, Germany, and Austria, and also from Canada, the United States, Mexico, Japan, and Siam.

A SECTION of experimental biology in which tissue culture figures prominently has been planned for the tenth meeting of the International Zoological Congress which meets in September in Buda-Pesth. So far as we are aware, this is the first time that tissue culture has practically a whole section devoted to it at an international scientific gathering. Numerous papers and demonstrations figure on the programme. Prof. Ross Harrison, who may be regarded as the founder of tissue culture, will very appropriately open the proceedings on Sept. 5, and Drs. Carrel, Warren H. Lewis, Levi, Lumsden, and Maximow are among the workers who are contributing papers. There will be special discussions on the bearings of pathology on tissue culture (Sept. 7), and on vital staining (Sept. 8). Prof. Rhoda Erdmann, herself a distinguished worker in the sphere of tissue culture, is to be congratulated on her initiative in preparing a very interesting programme.

At the meeting of the executive board of the U.S. National Research Council the following general officers were elected: *Chairman*, Gano Dunn, president of the J. G. White Engineering Corporation, New York City; *first vice-chairman*, Prof. T. H. Morgan, president of the National Academy of Sciences; *second vice-chairman*, Dr. John C. Merriam, president of the Carnegie Institution of Washington; *third vice-chairman*, Prof. R. A. Millikan, California Institute of Technology, Pasadena. The permanent secretary of the National Research Council, Dr. Vernon Kellogg, and the treasurer of the Research Council, Dr. George K. Burgess, director of the Bureau of Standards, continue in these offices. The following new members of the executive board were elected: Prof. James F. Norris, professor of organic chemistry, Massachusetts Institute of Technology, Cambridge, Mass.; Prof. F. R. Moulton, professor of mathematics, University of Chicago; and John R. Freeman, consulting engineer, Providence.

VOLUME 19 of the Collected Research of the National Physical Laboratory, Teddington, is a quarto of 444 pages and is devoted to the work published by the Physics Department of the Laboratory during the years 1920-25. A large proportion of the papers deal with the heat-insulating properties of materials which are used or may be used in the construction of refrigerator chambers, and with the heat which is transferred to or from bodies by the convection currents they set up in the air surrounding them. Hygrometers suitable for use in cold-storage chambers are thoroughly discussed and new instruments described. High vacuum mercury condensation pumps have been considerably improved by the

staff of the Department, research in the direction of establishing the composition of the X-rays from various metals and of using the rays to analyse alloys and other substances has been continued, and some advance made towards the more efficient protection of the X-ray worker. The volume is full of most valuable information, and it shows clearly how much can be done for science and industry by ten or twelve active workers in a well-equipped laboratory.

Too much caution cannot be exercised in naked-eye observations of the sun and its total eclipse on Wednesday next, June 29. Several contributors to our supplement last week referred to the danger of looking at the sun through unsuitable glasses or screens before totality. If, however, it is desired to observe the passage of the moon over the sun's face, no better device could be used than the "Combined Dark-Adaptation Mask and Graduated 'Eclipsia' Screen," made at the suggestion of Dr. R. L. Waterfield and sold by Messrs. Theodore Hamblin, Ltd., 15 Wigmore Street, London, W.1 (price 5s.). By means of a film of varying density, it will be possible to look at the sun from time to time before totality, and during total eclipse to observe the corona without any screen at all. The device should be very useful to all who are arranging to watch the eclipse on Wednesday next.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on Thursday, July 7, at 8.30-11.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in chemistry at the Leicester College of Technology—The Registrar, Colleges of Art and Technology, Leicester (July 1). An assistant in electrical engineering at the Crewe Technical Institute—The Director of Education, County Education Offices, City Road, Chester (July 2). An analytical assistant in the laboratory of the Public Analyst and Chemist to the Council of the Borough of Stepney—The Town Clerk, Municipal Offices, Raine Street, E.1 (July 4). An assistant examiner in the Standards Department of the Board of Trade—Principal Establishment Officer, Board of Trade, Great George Street, S.W.1 (July 6). A principal of the L.C.C. School of Building, Ferndale Road, Clapham—The Education Officer (T.1.a), The County Hall, S.E.1 (July 9). An assistant lecturer in philosophy at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (July 9). Research chemists at the Building Research Station, Garston, Herts; the Chemical Research Laboratory, Teddington; the Fuel Research Station, East Greenwich, and local stations of the Physical and Chemical Survey of the National Coal Resources—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (July 11). Research Physicist at the Building Research Station, Garston, Herts—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (July 11). An assistant govern-

ment chemist under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (July 14). A glass-blower for the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (July 14). A junior scientific officer for the Air Ministry Scientific Research Staff, primarily for research work in the aerodynamics department of the Royal Aircraft Establishment—The Chief Superintendent, R.A.E., South Farnborough, Hants (July 16, quoting A.180). A zoologist and a hydrologist for the *Discovery* Expedition—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (July 16). A research entomologist at the Long Ashton Fruit Research Station—Registrar,

University, Bristol (July 16). An assistant lecturer in geology—Registrar, University, Manchester (July 16). A live-stock officer and an assistant agricultural officer for the department of agriculture, Kenya Colony—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (July 31). A lecturer in physics at University College, London—The Assistant Secretary, University College, Gower Street, W.C.1. An assistant teacher in the engineering department of the Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18. Laboratory attendant for botanical department of University College, Leicester—Dr. E. N. Miles Thomas, 8 Inglewood Mansions, West End Lane, London, N.W.6.

Our Astronomical Column.

COMETS.—Comet Pons-Winnecke, 1927c, is now very near the earth; on the night of June 26-27 it will approach within about $3\frac{1}{2}$ million miles, which is closer than any cometary approach within living memory. Since, according to Mr. B. M. Peek, the nucleus is well-defined, it is worth while to take carefully timed photographs with the view of determining the solar parallax. The comet should be faintly visible to the naked eye as a large ill-defined area of faint luminosity. Its apparent motion will be as rapid as that of the moon in apogee.

Mr. B. Strömberg has revised the orbit, using observations up to June 10, and obtains:

$$\begin{aligned} T &= 1927 \text{ June } 21.064 \text{ U.T.} \\ \omega &= 170^\circ 22' 35.0'' \\ \Omega &= 98 \quad 8 \quad 34.3 \\ i &= 18 \quad 56 \quad 25.9 \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} 1927.0$$

$$\begin{aligned} \log e &= 9.836076 \\ \log a &= 0.519227 \\ \log q &= 0.016698 \end{aligned}$$

EPHEMERIS FOR 0^h U.T.

	R.A.	Decl.	log r.	log Δ .
June 23.	19 ^h 16.6 ^m	37° 41' N	0.0169	8.699
25.	20 10.1	24 21	0.0173	8.623
27.	21 3.7	5 54 N	0.0181	8.591
29.	21 52.2	12 2 S	0.0192	8.633

On June 23 the comet is some 7° east of Vega; on June 24, 5° north-east of β Cygni; on June 26, in the diamond formed by the bright stars of Delphinus; on June 27, near α Equulei. It then runs rapidly southward and quickly passes out of our reach, but it will be followed in Australia and South Africa. Perturbations by the earth will have to be applied in further researches on its motion:

CONTINUATION OF THE EPHEMERIS OF COMET 1927d (STEARNS) FOR 0^h (Pop. Ast., June-July).

	R.A.	N. Decl.	log r.	log Δ .
June 24.	14 ^h 1 ^m 21 ^s	22° 55'	0.577	0.530
July 2.	13 59 40	23 34	0.579	0.547
10.	13 59 10	24 0	0.581	0.563
18.	13 59 47	24 19	0.584	0.579

Magnitude 10 to 11.

CONTINUATION OF THE EPHEMERIS OF COMET 1927e (GRIGG-SKJELLERUP) FOR 0^h.

	R.A.	N. Decl.	log r.	log Δ .
June 25.	16 ^h 33 ^m 30 ^s	50° 40'		9.462
29.	16 53 40	46 30	0.0548	9.502
July 3.	17 10 30	42 21		9.541
7.	17 23 0	38 43	0.0679	9.579
11.	17 33 0	35 28		9.616

Magnitude about 11.

A FIREBALL ON JUNE 10.—Mr. W. F. Denning writes that "a fireball, estimated to be twice as

bright as Venus, was observed from Boscombe in the strong twilight on June 10 at 9^h 3^m P.M. G.M.T. It passed from about 20° below the Polar Star towards the east through the stars in the lower part of Cygnus, its path slightly falling during the five seconds the object remained in view. It left a short trail, and was apparently directed from a radiant point in the western sky. The fireball must have been a very brilliant object as seen from the central and eastern counties of England, but no report of its appearance has been received from those parts.

"It is hoped that further descriptions of its flight amongst the stars will be communicated, for the fireball was one of the most interesting and conspicuous kind, though the prevailing twilight must have considerably moderated its brilliancy."

PHOTOGRAPHS OF MARS.—Lick Observatory Bulletin 387 contains a series of photographs of Mars taken in 1924 by R. J. Trumpler. Yellow and red screens were used on the 36-inch refractor, and the plates were bathed in pina verdol. The plates were used to determine the diameter and polar flattening; the diameter was got both from limb measures and from measures of markings on the disc at different times, the rate of rotation being well known.

The limb measures gave (for unit distance):

	Yellow Screen.	Red Screen.
Equatorial diameter	9".41	9".33
Polar diameter	9".32	9".24
Polar flattening	1/96	

The measures of disc markings gave:

	Yellow Screen.
Equatorial diameter	9".178
Polar diameter	9".075
Polar flattening	1/89

It is concluded that the flattening exceeds the value 1/190 deduced by H. Struve from the Satellites.

RARE ASTRONOMICAL BOOKS.—A sale catalogue of more than usual interest just issued by Henry Sotheman and Co. includes the library of the late Dr. Dreyer. There is an extensive collection of books by Sir Isaac Newton, and by others relating to his work. A specially interesting work is the copy of Euclid's elements used by Newton when he commenced the study of geometry as a sub-sizar at Trinity College. This contains numerous MS. notes of his, which are said to have been written at various periods of his life; they express many of the propositions in algebraic notation. This work is valued at £500. Copies of the first edition of the "Principia" (first and second issues) are valued at £35 and £42 respectively. The second edition is only £2:5s.

Research Items.

AUSTRALIAN STONE IMPLEMENTS.—A paper on stone implements found on the camping grounds formerly used by Australian aborigines, by Mr. A. S. Kenyon, in *The Victorian Naturalist*, vol. 43, No. 10, which describes the character of these implements and their uses, suggests certain general considerations which are not without interest to students of the use of stone in prehistoric times in other parts of the world. The Australian camping grounds are of three types—those of a purely temporary character, where the remains are of food entirely; those where good shelter and varieties of food were obtainable, but here implements are sparse and of a crude nature; and thirdly, those that were permanent and at which aborigines were always to be found, and where the old men and women stayed and practised their arts and crafts. The first evidence of a camping ground is the presence of foreign stones, which may be either implements or fire stones; and the second the presence of food remains, often large quantities of shell of an edible kind. Raised beaches, especially around Port Phillip, have often been mistaken for kitchen middens. Examination reveals that the foreign stones fall into the following groups, apart from fire-stones: (a) small but definite shapes, mostly retouched; (b) larger shapes, much less definite, with secondary working of a much coarser nature; (c) similar flakes without retouching; (d) large pieces with coarse chippings; (e) cores. By far the greater number show no sign of working, but cannot be classed as 'wasters.' The aboriginal did not spend time on the elaboration of an implement when once he had obtained the edge he required, and it was thrown away perhaps after a few strokes, when once the edge showed the effect of use.

MAN'S PLACE OF ORIGIN.—In the issue of the *Scientific Monthly* for May, Dr. William K. Gregory surveys the evidence bearing upon the antiquity of man in its relation to the question of his place of origin, inclining strongly to the conclusion that it must be sought in Asia. He naturally attaches considerable importance to the discovery in 1921 in a cave at Chou Kou Tien, south-west of Peking, of the two human teeth (pre-molar and molar) of Upper Pliocene or Lower Pleistocene age. The close relation in structure between, say, man and the chimpanzee points, in view of the high estimate of geologic time accepted by some authorities, and the slow and unequal rate of evolution apparent when the palaeontological data are studied comparatively, to a separation at a period far later than the Lower Eocene. It also supports Darwin's view that man is an offshoot of the primates of the Old World rather than the New. In the Old World, notwithstanding the close approach to human conditions of *Dryopithecus rhenanus* of the European Pliocene, and the provenance of the most primitive known skulls (Pitldown, Heidelberg, etc.), Europe is not a likely place of origin. Notwithstanding the occurrence of members of the man-anthropoid series in the Lower Oligocene of Egypt, central Asia affords the most likely geological evidence of suitable avenues of distribution—this conforming with the peripheral distribution of Pithecanthropus and the Wadjak and Australian skulls, while the Nebraska tooth probably represents a migrant from eastern Asia. The geological, palaeontological, and anthropological data from central Asia have suggested the hypothesis that a gradual uplift of this area afforded the cause and the conditions of a gradual evolution of man in group after group of higher types, the lower migrating continuously on the receding lines of the changing environment.

MEDIEVAL ANATOMICAL TEXTS.—The subject of medieval anatomy to which we directed attention some time ago (*NATURE*, Dec. 5, 1925, p. 811) has recently been brought before us again by Dr. George W. Corner, professor of anatomy in the University of Rochester, U.S.A., in a scholarly treatise which contains a commentary and translation of the more important anatomical texts as well as a bibliography and facsimiles of some of the manuscripts. Dr. Corner has skilfully disentangled the historical facts from the legendary matter connected with the school of Salerno and Constantine the African, whom, like Sudhoff, he regards as one of the founders of modern medicine and indeed of all modern biology. Dr. Corner emphasises the fact, which does not appear to be sufficiently realised, that the translations of Constantine and the school of Salerno gave the Occident some of the fruits of Oriental medicine a hundred years before the later Arabic philosophers and physicians were translated at Toledo. The anatomical texts of the twelfth century consisted partly of three documents known as the two Salernitan demonstrations, one of which was called "Anatomia Cophonis," and "Anatomia Mauri," which were used as practical manuals for teachers and students, and partly of systematic descriptive anatomical works, in which the subject is handled in a highly organised style in accordance with the fashion of medieval scholasticism. Dr. Corner also gives an interesting account of a thirteenth-century text of a work named "Anatomia Vivorum" or "Anatomia Ricardi Anglici," which he regards as one of the very first books of the Middle Ages to show the influence of Aristotelian biology.

FORAMINIFERA FROM THE SUEZ CANAL.—The Cambridge Expedition to the Suez Canal in 1924 collected Foraminifera at nine stations, lying between the Great Bitter Lake and Gulf of Suez, and they are discussed by E. Heron-Allen and A. Earland in *Trans. Zool. Soc. London*, vol. 22, Part I., No. 9, Dec. 1926. The gatherings were not large and yielded few species, most of which belonged to the 'porcellaneous' group. There is no evidence of movement of any species from north to south (e.g. from the Mediterranean through the Red Sea), but there is thought to be positive evidence of one Indo-Malay and South African species—*Polystomella Milleti* H.A. and E., also found at Suez—migrating northwards, although only represented from the Bitter Lake by one specimen. A single specimen of *Polystomella craticulata* (Fichtel and Moll) occurring in the Bitter Lake is regarded as almost equally strong evidence of northward migration of that species. It is, however, hazardous to draw conclusions from single specimens, and under the heading 'Known Distribution,' P for Palermo is given (perhaps a misprint), although in the text it is stated that *P. craticulata* has not, so far as the authors are aware, been recorded from the Mediterranean. It is interesting that nearly all the Suez Canal specimens of Orbitolites are abnormal in some way, a peculiarity attributed to the variations in salinity which are apparently productive of deformed and monstrous growth. Three species are recorded, but all differ somewhat from the types, the usual specific characters being more or less obliterated. There is a list of the species of Foraminifera collected comprising 50 in all, 38 being taken in the Bitter Lakes and the remainder at the southern entrance of the Canal. Of the 38, 5 are known from the Indo-Pacific and not from the Mediterranean, and the remainder are from both areas.

A NEW MUTANT IN DATURA.—In the experiments of Drs. C. S. Gager and A. F. Blakeslee (*Proc. U.S. Nat. Acad. Sci.*, vol. 13, p. 75) mutations appear to have been produced by the action of radium emanations on the ovary of the plant *Datura Stramonium*. In the successful case an exposure of 10 minutes, probably just after the reduction divisions in the ovules, resulted in 17.7 per cent. of mutations among 113 plants, whereas the normal rate of mutation is about 0.47 per cent., and an untreated capsule of the same plant gave 36 offspring, all normal. The mutants were mostly forms with an extra chromosome, but included two new gene mutants (found in the offspring of 18 plants tested) and a peculiar type called 'nubbin.' The latter has an extra chromosome, but from various lines of evidence Blakeslee concludes that its composition probably includes two chromosomes each made up of the halves of different chromosomes. Unlike the other trisomic mutants, 'nubbin' gives rise to five different types in its offspring. The radium treatment is held to be 'largely responsible' for all three types of mutation obtained.

PLANT ECOLOGY OF PORTO RICO.—Volume 7, parts 1 and 2, of the "Scientific Survey of Porto Rico and the Virgin Islands," published by the New York Academy of Sciences, is devoted to an account of the ecology of Porto Rico by H. A. Gleason and Mel I. Cook. This work of 173 pages and 50 excellent photographic plates is the result of a few months' field work on the island. All the principal types of vegetation over some 3400 square miles of country were examined, and the results are given as purely those of a field survey, but as such form a good basis for more intensive work of a statistical or experimental nature. Works on island floras (e.g. Cooper's "Climax Forest of Isle Royale") are of a special interest from a successional point of view, as factors can be delimited in a manner scarcely possible in the case of continental floras. The authors distinguish three distinct vegetation regions, that of the Northern Coastal Plain, that of the Central Mountain Region, and that of the Southern Coastal Plain. Most of the first region is covered with limestone deposits, which develop a mesophytic upland forest, now nearly destroyed by settlers. Besides these mesarch associations, xerarch, hydrarch, and halarch series are found, the latter in the form of mangrove swamps, and all of those tend towards the development of a Playa Land Climax Forest. The Central Mountain Region was originally entirely covered by forest, except for minor areas of rock outcrops. The forest comprises five ecological types, in which the causal factors seem to be altitude, rainfall, and exposure. Only fragments of lower level forest now remain, but the vestiges show strong floristic relationship to the xerophytic forest of the Southern Coastal Plain. Between 2000 ft. and 3000 ft., the forest is mesophytic in character, consisting of a moist tropical forest and a tropical rain forest. The higher peaks are clothed by the Sierra palm forest and the mossy forest, the two types being differentiated chiefly by their exposure to wind. Each of these five ecological types is associated with a definite set of climatic conditions, which are not subject to modification by the vegetation, and each may thus be regarded as a climatic climax formation. A vegetation map would have been an acquisition to the work.

THE LIAS OF THE MEDIAN PRÉ-ALPS.—The nappe of the Median Pré-Alps has been referred by different authors in turn to each of the three zones of sedimentation—Helvetian, Pennine, and Austro-Alpine—which have contributed to the great recumbent folds of the western Alps. A very careful study of the

stratigraphy and fauna of the Lias of the difficult region south of Lake Geneva has been made by E. Peterhans, and his results are published in the *Mémoires de la Soc. Helvétique des Sci. Nat.*, vol. 62, 1926, Mem. 2. It is clearly shown that the Liassic fauna of the "Medianes" is definitely different from those of the Helvetian and Austro-Alpine regions, and that it probably belongs to the Pennine region. The latter deduction, however, cannot be directly proved, for the corresponding rocks of the Monte Rosa nappe are thoroughly metamorphosed. The provisional assumption by some of the Swiss geologists that the "Medianes" represented an extreme north-westerly thrust of the Austro-Alpine nappes, had to face the difficulty that the folding of the "Medianes" is of a type that implies the former presence of a heavy cover. It is now possible to regard this vanished cover as an Austro-Alpine nappe, part of which still remains in the inner belt of the Pré-Alps. The most puzzling feature of Alpine architecture thus still remains, for the push of the Austro-Alpine nappes far to the north-west of their roots still awaits a mechanical explanation.

CLIMATE AND ANIMAL EVOLUTION.—In the memoir entitled "The Environment of Tetrapod Life in the Late Paleozoic of Regions other than North America," published by the Carnegie Institution of Washington, Prof. E. C. Case continues that study of the land animals of Permian time and of the environment in which they lived which has occupied him for some twenty years and formed the subject of those well-known works on the American Permian fauna to which the present volume forms a supplement. Prof. Case holds that, within any restricted period of time, correlation of beds by conditions of environment is a more satisfactory method of understanding the relationships of faunas than is an attempt to establish correlations on the basis of an equivalence with marine deposits. In his former work, Prof. Case was able to show that the animals which form part of the 'Texas' Permian fauna are constantly associated with definite conditions of the environment in which the rocks containing their remains were laid down. He has now added to his very great experience of the American Upper Palaeozoic an acquaintance with rocks of similar age in many other parts of the world, founded not only on the literature, but also on a personal examination. The resulting work is most valuable because it brings together in a well-arranged form a vast mass of information on the geology and palaeontology of the continental Permian deposits of the rest of the world and discusses the conditions under which they have been laid down. The most interesting general conclusion is that the evolution which takes place in the members of a fauna must be associated in some way with the concurrent climatic changes in the area in which they are living.

MISSISSIPPI FLOODS.—The slow sinking of the lower Mississippi valley was suggested as a cause of the floods by Dr. D. E. White at the recent meeting of the American Shore and Beach Preservation Association. According to a report issued by Science Service of Washington, Dr. White pointed out that while there is no certainty that the gulf coast is sinking, the undoubted downward movement of the Atlantic coast is significant. The region to the north of the great lakes is being tilted upward, which suggests that farther south there may well be an area of depression probably with some warping or twisting of the earth's crust. He cites the well-known occurrence of earthquakes in the Mississippi valley between Cairo and Memphis as probable confirmation of this movement. The rate of sinking,

if it occurs, is no doubt very slow, but it will cause an increasing liability to floods, and furthermore, by reducing the speed of the currents, will render it more difficult for the lower river to keep its bed clear of sediments. Dr. White raised another problem with regard to the silting up of river channels. The levee system is based on the assumption that streams so confined will scour their own channels, but this, he maintains, has not been proved. If the river really drops its load of silt in the bed instead of carrying it out to sea, eventually the bottoms will be higher than the banks, and the raising of the levees to keep pace with this growth will cause increasing peril to the lowlands. Dr. White advocates the national importance of a study of these problems.

GEOPHYSICS IN THE UNITED STATES.—The report of the seventh annual meeting, on April 29–30, 1926, of the American Geophysical Union, has recently been issued as Bulletin No. 56 of the National Research Council. More than a hundred of its 134 pages are devoted to reports and summaries of papers read in the six sections and the general meeting. They afford a valuable and interesting record of American views on the problems of geophysics as a whole, and of their activities and observations within their own large and important field of work. At the general meeting the constitution of the earth was discussed, in the light of cosmical theory, gravity measurements, seismic and magnetic data, and chemical investigation. The section of volcanology also instituted a symposium, not confined to its own special viewpoint, on co-operation in the scientific investigation of the Aleutian Islands. Many papers in the remaining sections dealt with recent instrumental advances and programmes of observation completed or in progress.

THE PHOTO-ELECTRIC PROPERTIES OF MERCURY.—A number of troublesome effects produced in photo-electric work by impurities have been made the subject of a special study by H. K. Dunn. The experiments, carried out under the direction of Prof. Millikan and described in the May number of the *Physical Review*, were performed under conditions similar to those employed in the standard determination of the photo-electric threshold of mercury, with a continually renewed surface, and have incidentally confirmed Kazda's value of 2735 Å.U. for the limit. When the surface flow was stopped in a high vacuum, the threshold rose quickly to 2850 Å.U., and then in the course of a few days fell to 2680 Å.U. If liquid air was not kept on the traps, radiation of still higher frequency was required. The contamination seemed to be due to some relatively non-volatile substance other than water, which was given off by the tap-grease used. With pure hydrogen over the surface, the behaviour was exactly the same, but the presence of hydrogen which had been distilled with the mercury and was apparently in solution in the metal, greatly retarded the rate at which the active impurity became effective. It is suggested that in this case, as well as in other instances where the photo-sensitivity of a plate has been found to be increased by electrolytic generation of gas on the side remote from that exposed to the radiation, undesirable impurities are carried off by the gas diffusing through the substance.

MOVING MAGNET GALVANOMETERS.—Dr. C. V. Drysdale, in the May number of the *Journal of Scientific Instruments*, points out that recent improvements in the design of moving magnet galvanometers have made them for many purposes superior to moving coil galvanometers. By improving the design of the moving system and using cobalt steel magnets of very

small dimensions, A. V. Hill and A. C. Downing have succeeded in making galvanometers about 500 times as sensitive as Kelvin four-coil galvanometers. The most serious drawback to moving magnet galvanometers is their susceptibility to magnetic disturbances. This difficulty has been overcome by using a thin cylinder of the new high permeability nickel iron alloy which is generally known as mumetal or permalloy. A simple experiment is described showing the effective nature of this screening. A light cobalt steel magnet suspended by a quartz fibre was found to oscillate with a period of one second in the earth's field and was very sensitive to the motion of a bar magnet at some distance away. When it was screened by a permalloy cylinder closed by plates of the same metal, the time of oscillation was increased to more than ten seconds and the effects of the external bar magnet were negligible. The screening results obtained are far better than those got in the ordinary way by using massive soft iron bells. A notable advance has therefore been made.

CORROSION OF METAL JOINTS.—In the *Journal of the Royal Society of Arts* for April 29, Dr. U. R. Evans discusses briefly the problem of corrosion in general. After the consideration of troubles arising in welded, riveted, or soldered joints, the paper concludes with the following: The choice of materials which are to come in contact at a joint should be made with a view to minimising the E.M.F., although in some cases it may be advisable to make the metal presenting the smaller area weakly cathodic to the other. The nature of the joint itself is important, and care should be taken to avoid crannies which will be anodic to the main surface. Perhaps the most dangerous condition is a capillary crevice existing between the two dissimilar metals. Here the portion of the surface of the nobler metal near the mouth of the crevice will function as the cathodic area, whilst inside the crevice the base metal, and often the noble metal also will suffer anodic attack. It is important whenever possible to apply some coating of efficient protective paint, varnish, or plastic composition to the joints, with special reference to places where microscopic crannies may exist. The possibility of bulging due to cranny-corrosion is another matter of which account must be taken, the size and strength of the pieces being chosen to resist the stresses exerted by the volume changes involved in the corrosion process. The paper contains an interesting discussion from the electro-chemical point of view of the soldering of aluminium.

POTASSIUM NITRATE AS A FERTILISER.—For the enrichment of artificial fertilisers, potassium nitrate appears to possess so many advantages over other compounds of nitrogen that extensive field experiments have been undertaken by the *Agrikultur-chemische Versuchsanstalt der Landwirtschaftskammer* in the province of Saxony and also in Cassel. The association of potassium with nitrogen in the salt renders it more valuable for this purpose than sodium nitrate, which also possesses the disadvantage of being much more soluble at the ordinary temperature. Since, however, the proportion of potassium to nitrogen is too great, the salt must be suitably mixed with other materials. In the *Chemiker-Zeitung* for May 7 is an account of the first year's experiments upon comparisons between potassium nitrate and other nitrogenous salts. The results seem promising, but it is too soon as yet to draw any definite conclusion. Further reports will be awaited with interest. The tests were carried out with winter-corn, oats, tobacco, potatoes, beetroot, etc., partly on the land and partly in pots.

Chemical Industry and Technical Institutions.

MR. W. J. U. WOOLCOCK, general manager of the Association of British Chemical Manufacturers, delivered a striking address to the annual conference of the Association of Teachers in Technical Institutions which was held at Plymouth on June 4-7. Dealing with technical education and industry, he illustrated his theme by reference to chemistry, pure and applied. With this in mind, he traced the growth of the British chemical industry, which is now, he said, among the six greatest industries of the country; £200,000,000 capital is invested in it; it employs a quarter of a million workers and is exceedingly well organised. Not very long ago its range was small and, in Great Britain, relatively unimportant: to-day it provides the largest field for the scientific chemist. It has made greater strides in its post-War development than any other British industry, and is of such a wide character that it is difficult to set limits to its boundaries.

Three new points are, however, to be noted. While at one time chemical industry was practically the only outlet for the trained chemist who desired to apply his knowledge to industry, there is now no industry which cannot be benefited by the application of scientific knowledge to its control and development. There is, therefore, an almost unlimited field for the technically trained man or woman. Again, the post-War developments have been specially remarkable. Actually, of course, we have always had some sort of chemical industry in Britain, but what is called chemical industry is really an aggregation of a number of industries in many of which we have held our own for more than half a century. Particularly is this true of what are known as the heavy chemical industries. But since the War we have developed and maintained the fine chemical industries such as dyestuffs (the Dyestuffs Act helped considerably), research, medicinal, and photographic chemicals. We are therefore able to speak now with America, Germany, France, or Switzerland in brotherly terms, not in the terms of the poor relation.

There remains a third point, which refers to the boundaries formerly set between scientific and 'non-scientific' industries. Already it has been pointed out that there is no industry which cannot be benefited by scientific methods; it is also true that there is a number of industries doomed to extinction if such methods be neglected. "Thus," said Mr. Woolcock, "I say not only to the chemists here, but to the physicists, electricians, and especially to the biologists, that whatever industry you enter, or

whatever part you have to play in teaching those who may become industrialists, yours is a great vocation. I use no words of exaggeration when I say that the future of this country can be very largely influenced by what you can do." He was not concerned at the moment, he said, with the philosophical implications of technical education. He wanted to look at it from the viewpoint of what sort of men and women it produces—a test upon which technical teachers should be prepared to be judged. After all, the business man has to fit the product of teaching into the realities of his business. He can therefore recognise its good results in his own practical affairs, and he is bound to notice what appear to him to be its deficiencies.

On the whole, the present system gives satisfactory results, but there remain certain deficiencies to be made good. Mr. Woolcock would suggest that there is not available a sufficient number of trained scientific persons who have been taught from the point of view of economy. It is possible to teach the principles of chemistry and engineering in such a way as to inculcate throughout those conceptions of efficiency with regard to expenditure on material, labour, wear and tear of machinery and plant, heat, light, power, and so forth, which are essential to industry. It may be replied that this is already being done in some measure; but it must become far more general and must start quite early in the training of young scientific workers. An important aim, too, of technical education is the acquirement of ability in experiment, and by this is meant not only manipulative skill, but also imaginative conception. The teaching of manipulative skill is bound to vary in quality in accordance with the standard of the teacher. That cannot be avoided, but it is still possible that manipulative skill and manipulative conception can be developed in all their bearings from the point of view of their quantitative efficiency. From this it seems to follow that there is need to widen the scope of technical education. It might usefully include administration, costing, and production.

In his sketch of the development of the chemical industry, Mr. Woolcock said that, following the addition of fine to the heavy chemical industries, another development is taking place right under our eyes. It is a development along lines of production in enormous quantities of commonplace articles. "Undoubtedly," he said, "the industry has provided a bigger outlet than any other in the country for your students."

The New Experimental Station of the Safety-in-Mines Research Board.

THE official opening on June 14 of the new Experimental Station of the Safety-in-Mines Research Board at Harpur Hill, near Buxton, is an event of much importance in the mining world. It was fitting that the ceremony should be performed by Lord Chelmsford, chairman of the Miners' Welfare Fund Committee, and should be welcomed in no uncertain tones by Mr. Herbert Smith, president of the Miners' Federation.

Lord Chelmsford, in his speech, made it clear that the assistance of the Welfare Fund had only been obtained on two conditions: (1) that the nature and locality of the Station should be approved by both the owners and miners, and (2) that the experimental plant and its scientific equipment should be the best that could be designed for the purpose. When the Committee was unanimous on these two essentials it

had no difficulty in allocating a large capital sum for acquiring and equipping the site at Harpur Hill for the experiments which could only be carried out on a large scale, and for erecting at Sheffield buildings for laboratory researches especially connected with the properties of coal and with improvements in the miners' safety lamp. Besides this capital expenditure, an endowment fund of £250,000 had been invested to provide an annual income for the purposes of research.

The Committee, Lord Chelmsford added, did not suppose that immediate practical results would follow from a few scientific experiments; it is realised that the problem of securing safety in mines becomes more and more complex as the workings are extended, and it is only by the most patient research—not by one man, but by a trained staff working under skilled

direction—that progress can be made. Fortunately, the country possesses in the Research Board a body of experts, administrative and scientific, who can advise on the work, and in Dr. Wheeler it has a director of research who commands the full confidence of the Board. What is eminently desirable is to maintain the closest touch between the mining industry and the Research Board. The public are deeply interested in the problems the Board has to solve, and it should not be beyond the wit of man to keep the public informed of the methods used and the results obtained in language which can be followed by ordinary folk unversed in scientific formulæ.

After the opening speech, the chairman, Col. Lane-Fox, the Secretary for Mines, called on Mr. Eustace Mitton on behalf of the Mining Association (in the absence through illness of the president, Mr. Evan Williams), and on Mr. Herbert Smith, president of the Miners' Federation. The latter at once struck a note to which the large audience were responsive. "There are two things," he said, "in regard to which coal-owners and miners are always friends—first, how to save life and limb, and secondly, how to rescue when life and limb are at stake." On that platform they stood as one. He warmly commended the Welfare Fund, and the work that had been done under the chairman's guidance. He admitted the difficulty of persuading miners that there is danger in coal-dust, and he recognised the importance of the artificial mine that demonstrated the destructive violence of a pure coal-dust explosion, but stated that the plant that appealed to him most as a Yorkshire miner was the building where artificial gob fires could be initiated and studied throughout their various courses.

On the new experimental station the most important sections of the research equipment are the two steel galleries which have been constructed for testing the explosibility of coal dusts under various conditions. One of these, in which the greater part of the systematic work will be carried out, is 4 feet in diameter and 1000 feet long. The other, which will be used mainly for demonstration explosions, is 7½ feet in diameter and 390 feet long. They are connected to fans arranged for creating a current of air in them in either direction.

The 4-foot gallery is equipped with instrument cabins every 100 feet, containing apparatus for measuring the pressures produced during the explosions and the speeds of the flames. These instruments are controlled from a distance at the observation station. Two special sections have been included in this gallery for investigating the effect of openings in the gallery (corresponding to the branches off an underground road) on the development of a coal-dust explosion.

Research on Firedamp Explosions.—The 7½-foot gallery is also used for the study of firedamp explosions. One of the principal series of experiments now in progress is to determine the distance to which the flame of an explosion can be projected along a roadway beyond the area originally occupied by the explosive mixture.

There is another gallery, one foot in diameter and 300 feet long, in use for studying the effect of restrictions in the path of the flame on its speed.

Research on Coal-mining Explosives.—The buildings for this work include (a) a research laboratory and gun-room in which photographic methods are used to investigate the flame and the pressure waves sent out by an explosive when it is fired, and (b) an explosion gallery and observation station where the igniting power of explosives under different conditions of detonation is tested directly by firing them into explosive mixtures of firedamp and air.

Research on Gob Fires.—Some coalfields suffer from fires which break out in the gob or goaf, the part of the mine where the coal has been worked. The building in which the study of gob fires is being made consists of a central chamber, 30 feet square and 8 feet high, simulating a goaf, with an air passage, approximately 6 feet wide by 7 feet high, circumscribing it. The main object of the research in progress is to determine the limiting conditions necessary for the production and ignition of explosive gas mixtures from a fire behind a stopping, and to study methods of sealing off a fire so as to avoid these conditions. Records of the temperature, and samples of the atmosphere at different points within the sealed-off area, can be taken periodically.

University and Educational Intelligence.

CAMBRIDGE.—Mr. Roger Fry, Sir John Marshall, and Prof. A. V. Hill have been elected honorary fellows of King's College. The Council has proposed to the University that the degree of LL.D., *honoris causa*, be conferred upon the Duke of Northumberland, Sir Archibald Denny, Sir Eustace Tennyson-D'Eyncourt, and Sir Charles Oman in connexion with meetings to be held at Cambridge this summer of the Institution of Naval Architects and of the Royal Archaeological Institute. It is also proposed that the degree of M.A., *honoris causa*, be conferred upon Lieut.-Col. J. E. Craster, late R.E. Sir Humphry Rolleston has been appointed to represent the University at the coming Imperial Social Hygiene Congress.

Mr. A. S. Besicovitch, of the University of Leningrad, has been appointed lecturer in mathematics. Mr. H. W. Florey, Gonville and Caius College, has been appointed to the Huddersfield lectureship in special pathology. Dr. C. M. Yonge has been nominated to use the University Table at the zoological station at Naples for six months.

The annual report of the Solar Physics Observatory gives an account of the preparations and programme of Prof. Newall's expedition to Aal in Norway for the total eclipse of June 29.

Mr. R. V. Sayce has been appointed lecturer in material culture and physical anthropology. Dr. J. Chadwick, Gonville and Caius College, has been re-appointed lecturer in physics and assistant director of radio-active research.

F. W. Shotton, Sidney Sussex College, has been elected to the Harkness Scholarship in geology. E. J. H. Corner, Sidney Sussex College, and A. L. Bennett, Christ's College, have been awarded the Frank Smart prizes in botany and zoology respectively. The Tyson medal, in astronomy, has been awarded to C. S. M'Leod, Emmanuel College, and the Mayhew Prize in applied mathematics to J. Hargreaves, Clare College. The Rex Moir Prize in engineering and the Ricardo Prize in thermodynamics have been awarded to J. N. Goodier, Downing College. The John Bernard Seely prize in aeronautics has been awarded to C. E. Maitland, Peterhouse.

A grant has been made by the Balfour Managers to E. B. Worthington, Gonville and Caius College, for researches on the plankton of the Victoria Nyanza.

EDINBURGH.—At the meeting of the University Court on Monday, June 13, it was intimated that the Highland and Agricultural Society had resolved to make a grant of £1000 towards the endowment of the Department of Research in Animal Breeding.

The Court decided to make an annual contribution of £50 to the newly established British Institute in Paris.

NEWCASTLE.—The Council of Armstrong College has made the following appointments: Mr. Clement Heigham to be professor of agriculture, in succession to the late Prof. D. A. Gilchrist; Dr. J. W. Heslop Harrison to be professor of botany in succession to Prof. J. W. Bews, resigned; Mr. James Holmes to be lecturer in geography (a new appointment).

Mr. Heigham was educated at Wellington College and Caius College, Cambridge. He was for some time director of studies in agriculture at Caius College, Cambridge, and during 1923 and 1924 was director of the Norfolk Agricultural Station. Since 1925 he has been farm director at the Ministry of Agriculture's Experimental Station at Rothamsted.

Dr. Harrison is an old student of Armstrong College. He was at one time head of the science department at Middlesbrough High School, and since 1920 has been lecturer in zoology in Armstrong College. In 1926 he was given the honorary title of reader in genetics. His researches on genetics, particularly on the question of the transmissibility of acquired characters, have made him widely known.

Mr. Holmes is a graduate of the University of Glasgow, and for the last four years has been senior assistant in the Department of Geography there.

OXFORD.—The great utility of the private laboratories belonging to Balliol, Trinity, Jesus, Queen's, and Christ Church has been recognised by the University in a recent decree authorising the payment of money grants to these laboratories which are to be equal to the normal laboratory fees paid by students working therein. It has long been recognised that Colleges which have scientific laboratories of their own have a very great advantage over those which are not so provided.

The preamble to a statute providing that there shall be an Aldrichian praelector in chemistry to be held by one of the University demonstrators has been approved.

ON June 7, in the presence of a great gathering representative of the west of England, and amid memorable scenes of enthusiasm, the Prince of Wales, president of the University College of the South-West of England, laid the foundation-stone of the new arts and administrative building of the College. The ceremony was of a peculiarly picturesque character and was enhanced by the magnificence of the exceptionally beautiful site which, known formerly as the Streatham Estate, forms one of the beauty spots of the south-west. The deputy-president of the College, Sir Henry Lopes, in welcoming the Prince, outlined the history of the rapid growth of the College, and explained that the increasing number of students and the rising standard and volume of academic work has impelled the College to find fresh quarters, more suited to the expanding needs. He stated that the appeal for a building and endowment fund, launched a few months ago, is evoking from month to month an increasing response. The greater part of the first £100,000 required has already been subscribed, and the lists show that all classes are contributing to the fund. The Prince in his reply congratulated the College on the support which the plans of expansion has evoked throughout the whole area. A people's university, created by the wishes and efforts of all classes, deserves the best that can be provided both as regards building and teaching, and he expressed the hope that the building would be a worthy monument to the hopes and ambitions of the people. His unexpected announcement that Lord Glanely is giving £25,000 to the appeal fund was received with enthusiasm.

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Calendar of Discovery and Invention.

June 26, 1794.—The balloon was invented by the French, and the French were the first to use balloons in warfare. In 1793 a company of military aeronauts was formed, Jean Marie Joseph Coutelle (1748-1835) was made captain, and at the battle of Fleurus, June 26, 1794, he made observations from a balloon which it is said contributed to the success of the French. Coutelle and his company accompanied Bonaparte to Egypt, but their whole equipment was destroyed in the burning of *l'Orient* at Aboukir.

June 27, 1889.—The statue of Leverrier at the Paris Observatory was inaugurated on June 27, 1889. In his discourse Tisserand said: "The celestial world gets larger every day. . . . Yet our curiosity is inexhaustible; and however splendid may be the heaven which we are permitted to contemplate, we want to attain to greater knowledge still. We strive to realise what it was like in the most distant past, and what it will become in the most distant future. In this way—so it seems to us—our mind takes its revenge upon the shortness of our span of life and the frailty of our existence."

June 28, 1903.—It was at a meeting held at the Academy of Sciences, Munich, on June 28, 1903, that the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik was founded. Its inception and development owe much to the acumen and energy of Dr. Oskar von Miller, and its purpose is to represent physical science and its application to industry from the earliest times to the present day.

June 30, 1820.—Among the numerous papers contributed to the Linnean Society by Robert Brown was that read on June 30, 1820, on *Rafflesia*, the largest known flower.

June 30, 1866.—For centuries a barrier to human intercourse, the Atlantic is now crossed by steamships, submarine cables, aircraft, and radio signals. The first submarine cable, laid in 1858, failed after being in use a month, while the second, laid in 1865, was damaged in the laying. On June 30, 1866, however, the *Great Eastern* left the Medway with 3000 miles of new cable. The shore end was spliced on July 13, and on July 27 the ship steamed into Heart's Content, Newfoundland. No one contributed more to the final success of the project than Prof. William Thomson, afterwards Lord Kelvin, who for his share was raised to the knighthood.

July 1, 1858.—On July 1, 1858, Lyell and Hooker communicated to the Linnean Society papers which they described as relating to the same subject, namely, "The Laws which affect the Production of Varieties, Races, and Species," and as containing the results of the investigation of two indefatigable naturalists, Mr. Charles Darwin and Mr. Alfred Wallace, who "independently and unknown to one another, conceived the same very ingenious theory to account for the appearance and perpetuation of varieties and of specific forms on our planet. . . ." Of his own share Wallace said, "The one great result which I claim for my paper of 1858 is that it compelled Darwin to write and publish his 'Origin of species' without further delay."

July 2, 1919.—The only aircraft which has flown to and fro across the Atlantic was the airship R34. With a crew of 26 she left East Fortune, near Edinburgh, on July 2, 1919, and reached New York in 4½ days. Her return was made in 3 days 3 hours. She was 645 feet long and 79 feet in diameter, contained nearly 2,000,000 cubic feet of gas, and was driven by five Sunbeam engines of 285 H.P. each. A year or two later she was damaged and then dismantled.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 16.—F. W. Aston: A new mass-spectrograph and the whole-number rule (Bakerian Lecture). By means of the first mass-spectrograph, built in 1919, the masses of all atoms, with the exception of hydrogen, were shown to be whole numbers on the oxygen scale, to one or two parts in 1000. In order to measure their divergence a more powerful instrument was necessary. This has been made, with a resolving power of 1 in 600, more than sufficient to separate the mass lines of the isotopes of any known element, and with an accuracy of measurement as high as 1 in 10,000. By means of this instrument the isotopic constitution of mercury has been decided, new isotopes discovered in sulphur and tin, and the two doubtful isotopes of xenon confirmed. 51 types of atom contained in 18 different elements, ranging from hydrogen to mercury, have been examined. Their masses and packing fractions, *i.e.* their percentage divergence from the whole numbers expressed in parts per 10,000, are tabulated on the oxygen scale; *e.g.*, the atom of phosphorus of mass number 31 has a packing fraction -5.6 ± 1.5 and a mass 30.9825. The relations of tin and xenon have been re-examined and found not to show the striking abnormality previously suggested. The values for Li^8 and Li^7 are obtained by a recalculation of Costa's results. When the packing fractions of the atoms are plotted against their mass numbers, for all atoms above mass number 20 these lie roughly on a single curve. From mercury, packing fraction $+0.8$, the curve descends to -9 in the region of bromine. It then ascends, and in the case of atoms of odd atomic number continues to do so, in a roughly hyperbolic manner, right up to hydrogen $+77.8$. The light atoms of even atomic number have packing fractions well below this curve, and approximate to a branch rising much less steeply to helium $+5.4$. This suggests that the light atoms of odd atomic number have a common loosely packed, and therefore heavy, outside structure, which is not present in the denser and more stable nuclei of helium, carbon, and oxygen.

Linnean Society, May 12.—James Groves: Charophyta from Madagascar. Early in 1924, Mr. T. B. Blow made an extensive collection of Charophyta from Madagascar. Seven species of Chara were collected, all belonging to known and fairly distinct types. The representatives of the more intricate genus *Nitella* have proved difficult to discriminate. The new species described are probably mostly endemic to the island. None of the smaller genera is represented.—T. B. Blow: Observations on the alleged larvicidal qualities of Charophyta. Species of Charophyta were cultivated in large glass jars and mosquito larvae were introduced; the effect of the glucoside from dried *Chara zeylanica* was also tried. In every case the larvae enjoyed a vigorous life, and a large percentage attained to the winged condition.—T. A. Sprague and V. S. Summerhayes: The geographical distribution of some Santalaceae. An investigation into the taxonomic status of the Australasian genus commonly known as *Fusanus* "R. Br." (non Murr.) led to its being divided into two genera—*Eucarya* T. L. Mitch. (Australia) and *Mida* A. Cunn. (New Zealand). It was then discovered that the now extinct *Santalum fernandezianum* F. Phil. (Juan Fernandez) should be transferred to the genus *Mida*. The distribution of *Mida* is of exceptional interest, one species occurring

in New Zealand (North Island) and the other in Juan Fernandez. If it is monophyletic, the distribution may be interpreted as an extreme example of the well-known New Zealand-Chile (or South America) type, which is generally explained as the result of northward migration from the Antarctic continent. Possibly *Mida* had a diphyletic origin from *Santalum*, the ancestors of the New Zealand species having migrated from Australia and those of the Juan Fernandez species from Hawaii. The geographical distribution of *Santalum album* affords a problem of a different nature. *S. album* is known only from (1) southern India and (2) the eastern part of the Malay Archipelago, from eastern Java to Timor. This discontinuity may conceivably be due to extirpation by disease in the intervening area. A second hypothesis—that the species was introduced into India from eastern Malaya—is brought forward by Mr. C. E. C. Fischer.

CAMBRIDGE.

Philosophical Society, May 2.—E. G. Dymond: Excitation by high velocity electrons. With the velocity of the exciting electrons ranging from 100 volts to 1800 volts, the lines of the par- and ortho-helium series are reduced in intensity with increasing velocity, in roughly the same manner, and the intensities of the two series are of the same order of magnitude. This is in complete disagreement with work on the efficiency of excitation of the two series, made by an electron impact method. Excitation by fast electrons seems to proceed in two stages, the first being the excitation of the atom to any of a continuous series of states, and the second, the falling back into one of the normal series with emission of continuous radiation. The electron may lose any amount of energy greater than the lowest excitation energy. The process is similar to that put forward by Kramers and Heisenberg to explain the scattering of light.—A. Cress: Synthesis of ammonia by electrons.—P. A. Taylor: The light intensity of the calcium chromosphere. Prof. Milne's theory of the equilibrium of the calcium chromosphere is modified to take account of the curvature of the sun and the proper inverse square law of gravity. A method is developed for the calculation of the intensity of *H* and *K* radiation as observed in a telescope pointed near the limb of the sun in terms of the height above the limb of the point towards which the telescope is directed. Comparison of the calculated intensities with eclipse observations indicates that the co-efficient of partial support is probably of order of magnitude 10^{-4} .—F. H. Constable: On the effect of the addition of successive small quantities of poisonous substances on the velocity of catalytic gas reactions in closed vessels. A homogeneous distribution of centres of activity is more sensitive to the initial small quantities of poison than to the increments following. The experimental results of Pease and Stewart are used to show that there is a considerable change in the mean life of the carbon monoxide molecule on the most active, and least active, centres in the hydrogenation of ethylene by a reduced copper catalyst, showing that a distribution of centres does exist in this case, and that once the most active centres are poisoned the catalyst behaves as if it were homogeneous.—H. Jeffreys: Wave propagation in strings with continuous and concentrated loads. The nature of wave-propagation in a light string loaded with equal particles at regular intervals is discussed. There is no phenomenon similar to conduction of heat, but only dispersion. It appears probable, however, that irregularity of structure, if any, would introduce conduction.—S. Goldstein: On Mathieu functions.—M. E. Grimshaw: A case of distinction between Fourier integrals and Fourier series.

DUBLIN.

Royal Dublin Society, May 24.—Report of the Irish Radium Committee for the year 1926. Details are given of the treatment of more than two hundred cases with radium emanation supplied by the committee during the year.—P. O'Connor: A universal growth inhibitor in living tissue. The fluids of each species of plant or animal contain a simple diffusible substance of a specific character which is toxic to the protoplasm of all other species. This substance is not destroyed by boiling.—W. H. Fordham: The Eotvos torsion balance and vertical magnetometer.

EDINBURGH.

Royal Society, June 6.—Ethel D. Currie: Jurassic and Eocene Echinoidea from Somaliland. The collection, which belongs to the British Museum, comprises 14 Jurassic and 18 Eocene species. The Jurassic specimens, which are apparently all Bathonian, are from Bihendula and Ida Kabeitah in north central Somaliland and Biyo Dader in western Somaliland. New species of *Acrosalenia* and *Echinodiadema* are described and also a new genus, *Farquharsonia*, which has certain resemblances to *Archæodiadema*, *Hemipedina*, and *Orthopsis*. The fauna is European in affinities and implies a connexion between the Somaliland sea and the European sea of that time. The Eocene echinoids, collected in north central and eastern Somaliland, are from a lower cherty limestone and an upper white chalky limestone. The 11 species from the cherty limestone include a new species of *Pericosmus*, and are Lower Eocene. The 7 species from the upper white limestone, which include a new *Linthia* and a new *Opissaster*, are Middle Eocene. The author correlates the lower cherty and upper chalky limestone with the Auradli and Allahkajid limestones of Somaliland, thus reversing the supposed order of these two limestones.—A. Calder: A case of partial sex-transformation in cattle. A cow, following cystic degeneration of both ovaries, assumed the secondary sexual characteristics of the male.—W. O. Kermack and W. T. H. Williamson: The stability of suspensions (ii.). The rate of sedimentation of kaolin suspensions containing colloidal silicon dioxide. When kaolin suspensions contain a small quantity of colloidal silicon dioxide, the normal effect is one of weak protection, but under certain conditions an abnormally rapid rate of sedimentation occurs owing to the precipitation of a film of insoluble material over the surface of the particles. Under other conditions the abnormal rate of sedimentation, due to the formation of a film of this kind in the absence of silicon dioxide, disappears in its presence.—Amy M. Fleming: The peripheral innervation of the uterus. The work is a study of the part played in directing the activities of the uterus by the nerve structures which lie outside the central nervous system. It involved an anatomical study of the distribution of these nerve structures in lower animals and a physiological and pharmacological investigation of their mode of action. No evidence was obtained that the ganglia lying beside the cervix have any direct action, and the interaction of antagonistic drugs, while indicating the evidence of an intra-uterine control, failed to afford clear evidence of separate augmentory and inhibitory mechanisms.—W. L. Ferrar: On the consistency of cardinal function interpolation. A function $f(x)$ is obtained by interpolating from a set of values at $x=n$. The values $f(n-\lambda)$ are used to build up a new interpolation function $\phi(x)$. Under appropriate conditions $\phi(x)=f(x)$. The work is related to Titchmarsh's series inversion formulæ.—W. H. Lang:

Contributions to the study of the Old Red Sandstone flora of Scotland. (vi.) On *Zosterophyllum Myretorianum*, Penh., and some other plant remains from the Carmyllie Beds of the Lower Old Red Sandstone; (vii.) On a specimen of *Pseudosporochnus* from the Stromness Beds. *Zosterophyllum* is characterised by peculiar branchings with a backwardly directed division, giving the appearance of an anastomosis of two parallel stems, and axes with radially arranged, stalked, reniform appendages. The appendages suggests that they may be rather flat sporangia, but no spores have been demonstrated. The plant had a thick cuticle and an epidermis, possibly with stomata. There is a central vascular strand, composed of tracheides with annular thickening bands, traversing the linear axes. *Zosterophyllum* is the most ancient vascular plant known from British rocks. The indications are that it can be placed in the Rhyniaceæ. Certain branched linear axes of a wholly different structure are described. Linear spore-masses are enclosed in some cases by an investment of this construction. A specimen recently added to the Stromness Museum provides a record of the occurrence of *Pseudosporochnus Krejčíi*, known from the Middle Devonian of central Europe, in the Middle Old Red Sandstone of Scotland.—Sir Thomas Muir: The theory of orthogonants and latent roots from 1881 to 1918.

PARIS.

Academy of Sciences, May 16.—The president announced the deaths of Gustave André and of M. Tschermak.—A. Lacroix and F. Blondel: The existence in the south of Annam of a peperite resulting from the intrusion of a basalt into a diatomaceous sediment. There are two current views as to the origin of peperites, one (Julien) regarding them as formed by materials projected from basaltic volcanoes falling into lakes and cemented by calcite, the other (A. Michel-Levy) as resulting from the intrusion of a basaltic magma into limestone deposits. A detailed study of the Annam peperites is in agreement with the latter view.—Maurice Hamy: An empirical rule concerning the magnification of a telescope. A proof of the empirical rule that twice the aperture of the objective measured in millimetres gives the maximum useful magnification.—A. Bigot: The conditions of deposit of the upper Bathonian in the region of Caen.—Henry F. Osborn was elected *correspondant* for the section of mineralogy.—L. Leau: Method of recurrence or of complete induction applicable to space.—A. Kovanko: Suites of functions of class 1.—Louis Breguet: The maximum flying distances possible without descent and the transport capacity of aeroplanes of the future on long flights.—Thadée Peczkalski: The action of salts on metals. The phenomena described explain various facts observed in the thermo-ionic emission of incandescent metals covered with a layer of salts, especially the known fragility after long heating and the increase of the electronic emission.—F. Bedeau and J. de Mare: The direct standardisation of a wavemeter as a function of the harmonics of a tuning-fork.—St. Procopiu: The influence of mechanical actions and of alternating currents on the discontinuities of the magnetisation of iron.—D. Chalonge and M. Lambrey: The structure of the ultra-violet absorption band of ozone.—G. Colange: The influence of temperature on photographic impressions. Researches on the optical properties of the upper atmosphere necessitated a knowledge of the influence of low temperatures on photographic plates. Experiments have been carried out on the law relating photographic density and temperature between 15° C. and -60° C.

The results already obtained are sufficient to show the necessity of working at a constant temperature when making measurements of photographic photometry. A temperature variation of 5°C . introduces an error of $\frac{1}{10}$ in the comparison of the intensities of two sources of light.—A. Grumbach: Photovoltaic elements containing glycerol.—Mlle. Suzanne Veil: The magnetic behaviour of the modified hydroxides in the presence of hydrogen peroxide. From the observations given both from the magnetic and chemical point of view, treatment with warm water appears to paralyse the activity of nickel hydroxide. Experiments with ferric hydroxide lead to similar conclusions.—J. Cournot, J. Bary, and E. Perot: Coating aluminium, magnesium, light alloys, and ultralight alloys.—J. B. Fournier and Fritsch-Lang: The inalterability of commercial iron, copper, and zinc by liquid hydrogen sulphide. These metals are unchanged by prolonged immersion in liquid hydrogen sulphide and show no trace of corrosion or alteration.—Pariselle and Laude: The manganese hydrate carried down by alumina from an ammoniacal solution.—Albert Kirrman: The ethylenic organo-magnesium compounds.—Ch. Courtot and G. Vignati: Researches in the fluorene series.—P. Blanchet: A new layer carrying many fossils of the intra-Alpine Tithonic.—J. MacLaughlin: Measurements of the large ions at Paris. After discovering the large ions, Langevin put forward a theory concerning them of great importance in the physics of the earth. Two series of measurements of the large ions, carried out at Paris since 1925, confirm generally the views of Langevin. The present paper gives some of the first results of these measurements.—Malmgrön and Béhounek: Measurements of the electrical conductivity of the atmosphere in the region of the North Pole. An account of experiments carried out during the voyage of the dirigible *Norge* from Kingsbay (Spitsbergen) to Teller (Alaska) in the course of the Amundsen-Ellsworth-Nobile polar expedition.—E. Chemin: The development of the spores and the parasitism of *Harveyella mirabilis*.—A. Guillaumond: The cytology and sexuality of *Spermophthora Gossypii*.—St. Karasiewicz: The influence of sodium carbonate and calcium chloride on the acidity of the juice of *Zea Mais*.—L. Maume and J. Dulac: The variation of antitoxic power as a function of ionisation.—René Souèges: The embryogeny of the Leguminosæ. The last stages of the development of the embryo in *Trifolium minus*.—Maurice Fontaine: The influence of high pressures on the imbibition of the tissues.—Ch. Oberling: The existence of a neuro-muscular *housse* at the level of the glomerular arteries in man.—E. Lacroix: The texture of the shell of *Textularia sagittula*.—P. Nottin: The hydrolysis of starch by sulphuric acid. The experimental results given accord best with the view that sulphuric acid directly decomposes the amylaceous material into several products, glucose, maltose, other reducing substances and non-reducing glucides. The theory of successive reactions passing through a series of intermediate products is not confirmed.—Marc Romieu: A new histochemical reaction for the lecitines. The iodophil reaction. Lecithin gives a strong brown coloration when treated with a solution of iodine in potassium iodide. This resembles the brown colour produced by glycogen. It is probable that glycogen and lecithin may have been confused in earlier work.—L. Meunier, P. Chambard, and H. Comte: The pancreatic digestion of wool.—E. Wollman and Achille Urbain: Bacteriophagy and filtrable tumours. The fixation reaction in the Rous sarcoma.—C. Levaditi and A. Klarenbeek: The prophylaxy of the trypanosomiasis by ingestion of moranyl (309

Fourneau or 205 Bayer). Moranyl administered to the rabbit *per os*, exercises a profound and lasting prophylactic action with regard to *Trypanosoma Nagana*. Comparative traits made with *T. gambiense* have furnished analogous results.

SYDNEY.

Linnean Society of New South Wales, Mar. 30.—E. W. Ferguson: Medical and veterinary entomology in Australia (Presidential address). Only certain groups of insects are concerned in the transmission of disease, insects whose life-history comes into close association with man or animals. These insects nearly all belong to the orders Diptera, Siphonaptera, Hemiptera, and Anoplura. (a) Diptera (Flies). The mosquitoes carry in Australia three distinct diseases, malaria, dengue fever, and filariasis. Tabanidae: no disease has been definitely traced to this family, but owing to their biting habits they are suspect. Muscidae: the common house-fly is responsible for the spread of typhoid, infantile diarrhoea, and dysentery. All flies are not enemies, for many are useful in destroying other insects. (b) Siphonaptera (Fleas). The Indian rat flea, an introduced species, is the vector of plague from rat to rat and from rat to man. The stickfast flea has been the cause of economic loss in poultry in Western Australia. (c) Hemiptera (Bugs). The common bed bug has been introduced but is not known to carry any disease in Australia, which is fortunately free from other blood-sucking species. (d) Anoplura (Lice). The three louse-borne infections of man do not now exist in Australia. Hymenoptera (bees, wasps, and ants) though not disease-carrying insects, are of interest from two points of view: (1) many will attack human beings, inflicting severe stings, and (2) several are parasitic on flies of economic importance.—J. R. Malloch: Notes on Australian Diptera. No. x. A new subgenus of *Sapromyza* is described, and also new species of *Mycodrosophila* (1), *Leucophenga* (1), *Drosophila* (6), *Gitonides* (1), *Desmomelepa* (1), *Sapromyza* (5), *Homoneura* (3), and *Tapeigaster* (1).—Miss May M. Williams: The anatomy of *Cheilanthes vellea*. *Cheilanthes vellea* is one of the few xerophytic ferns. The stem stele is a dictyostele. The petiolar stele, as it leaves the stem stele, is a simple adaxially curved anarchy structure, but later three protoxylem groups appear. The pinnule has a reduced lacunar system, but a well-developed palisade. The stomata are confined to the lower surface of the pinnule and are protected by the inrolled margin of the pinnule together with a covering of hairs which grow out from the lower epidermis. The root is diarch. The apices of stem, leaf and root, and also the development of the sporangia, conform with those typical for leptosporangiate ferns. The sori are superficial and continuous, with a false indusium which is simply the inrolled margin of the pinnule. The number of spores does not exceed twenty.—John Mitchell: A new *Deltopecten* from the Illawarra district, N.S.W. The new species resembles *D. obliquatus*. It occurs in the Upper Marine beds, Permian-Carboniferous.—John Mitchell: The fossil *Estheria* of Australia. Part I. Only two species of *Estheria* have previously been recorded from Australia, namely, *E. Coghlani* Cox from Sydney, and *E. mangaliensis* Eth. Junr. from Ipswich. Eleven new species are described, and a new name is given to the species hitherto recorded as *E. mangaliensis*. These forms range back to the Upper Permian, when the species were of larger size than those obtained from the later Triassic formations.—G. D. Osborne: The geology of the country between Lamb's Valley and the Paterson River. The main portion of the area consists of a somewhat dissected plateau.—

C. Barnard: Note on a dicotyledonous fossil wood from Ulladulla, N.S.W. The specimen was obtained from the 'Silica' beds (Lower Tertiary) at Bannister Head, near Ulladulla, and is a piece of silicified wood. In structure the wood is that of a typical dicotyledon, and shows a very close agreement with that of the Saxifragaceæ, in which it is tentatively placed.—C. T. Musson and the late J. J. Fletcher: On a case of natural hybridism in the genus *Grevillea* (Proteaceæ). The flora of the higher portion of the Blue Mountains includes two species, *G. laurifolia* Sieb. and *G. acanthifolia* A.C., the plants of which differ markedly in many respects. Though belonging to different plant associations they frequently grow quite near each other under conditions that are often ideal for tempting birds to pass directly from the flowers of one species to those of the other. When these conditions prevail, certain rare and little known forms possessing intermediate characters are sometimes found.

Official Publications Received.

BRITISH.

British Museum (Natural History). Picture Postcards. Set E49: Mimicry in Insects, Series No. 1. 5 cards in colour. 1s. Set E50: Mimicry in Insects, Series No. 2. 5 cards in colour. 1s. (London: British Museum (Natural History).)

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield. Vol. 9, 1926. Pp. iii+324. (Sheffield.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 2, No. 12: The Structure of the Disturbed Deposits of Moens Klint, Denmark. By Dr. George Slater. Pp. 289-302+1 plate. 2s. Vol. 55, Part 2, No. 18: The Disturbed Glacial Deposits in the neighbourhood of Lønstруп, near Hjørring, North Denmark. By Dr. George Slater. Pp. 303-305+2 plates. 2s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Journal of the Institute of Actuaries Students' Society. Vol. 3, No. 1. Pp. 72. (London: C. and E. Layton.) 3s.

The Opening of the Safety in Mines Research Station, Buxton, by the Viscount Chelmsford, 14th June 1927. Pp. 4+12 plates+32. (London: Safety in Mines Research Board.)

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report (Thirteenth Year) 1925-26: Supplement. East Malling Research Station. Pp. 160+20 plates. (East Malling.) 5s. 6d.

Discovery Expedition. First Annual Report, 1926. Pp. 10+3 plates. (London: H.M. Stationery Office.) 1s. 6d. net

Norman Lockyer Observatory. Director's Annual Report, April 1, 1926-March 31, 1927. Pp. 8. (Sidmouth.)

The Official Guide to Twickenham. Fourth edition. Issued by Authority of the Twickenham Corporation and the Twickenham and St. Margaret's Chamber of Commerce. Pp. 72. (London and Cheltenham: Ed. J. Burrow and Co., Ltd.)

Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene and the Carmichael Hospital for Tropical Diseases, 1926; also a Brief History of the School and a Report for the Years 1920-1925. Pp. vi+152+27 plates. (Calcutta: Bengal Government Press.)

Memoirs of the Queensland Museum. Vol. 9, Part 1, April 28th. Pp. 126+17 plates. (Brisbane: Anthony James Cumming.)

Review of Agricultural Operations in India, 1925-26. By Dr. D. Clouston. Pp. v+152+10 plates. (Calcutta: Government of India Central Publications Branch.) 2.6 rupees; 4s. 3d.

Union of South Africa: Department of Agriculture. Bulletin No. 12: The Financial Side of Dairy Farming. By E. W. Sampson. Parts 1-5. Pp. 43. 6d. Bulletin No. 15: A Simple and Successful Septic Tank. By E. J. Van Meerten. Pp. 11. (Pretoria: Government Printing and Stationery Office.)

The Ross Institute and Hospital for Tropical Diseases (Incorporated), Putney Heath, London, S.W.15. Annual Report and Accounts for 1926. Pp. 36. (London.)

Malaria-Control in Malaya and Assam: a Visit of Inspection, 1926-27. By Sir Ronald Ross. Pp. 31. (London: Ross Institute and Hospital for Tropical Diseases.)

Empire Cotton Growing Corporation. Report of the Sixth Annual General Meeting. Pp. 18. (London.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 65, No. 366, June. Pp. 553-652+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Quarterly Journal of the Royal Meteorological Society. Vol. 53, No. 225, April. Pp. 97-200. 7s. 6d. Supplement to Vol. 53: The Meteorology of Solar Eclipses. By E. W. Barlow. Pp. 24. 2s. 6d. (London: Edward Stanford, Ltd.)

British Museum (Natural History). Picture Postcards. Set F18: British Orchids, Series No. 3. 5 cards in colour. 1s. Set F19: British Orchids, Series No. 4. 5 cards in colour. 1s. Set F20: British Orchids, Series No. 5. 5 cards in colour. 1s. Set F21: British Orchids, Series No. 6. 5 cards in colour. 1s. (London: British Museum (Natural History).)

Journal of the Royal Microscopical Society. Series 3, Vol. 47, Part 2, June. Pp. 14+97-307. (London.) 10s. net.

Natural Science in Adult Education. Paper No. 8 of the Adult Education Committee. Pp. vi+54. (London: H.M. Stationery Office.) 6d. net.

Committee on Bird Sanctuaries, Royal Parks, England. Report for 1926. Pp. 15. (London: H.M. Office of Works.)

FOREIGN.

U.S. Department of Agriculture. Farmers' Bulletin No. 1521: Propagation of Game Birds. By W. L. McAtee. Pp. ii+57. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 376: Geodetic Level and Rod. By D. L. Parkhurst. (Special Publication No. 129.) Pp. 12. (Washington, D.C.: Government Printing Office.)

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 8: The Ants of the Canary Islands. By William Morton Wheeler. Pp. 93-120+3 plates. 75 cents. Vol. 62, No. 4: The Ants of Lord Howe Island and Norfolk Island. By William Morton Wheeler. Pp. 121-153. 50 cents. (Boston, Mass.)

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the year 1921. Pp. xv+162. (Cairo: Government Publications Office.) 40 P.T.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 8, 1926. ii: Nedeiborden i Sverige. Pp. 159. (Stockholm.) 5 kr.

CATALOGUES.

Planetable Surveying Equipment. Pp. 12. (London: Cooke, Troughton and Sims, Ltd.)

Mathematical Models according to the Collection of Messrs. Weiner and Treutlein. Pp. 20. (Manchester and London: G. Chissons, Ltd.)

Clinical Pathology and the Use of Stains: with Price List of Standard Microscopic Stains. Second Impression. Pp. 16. (London: The British Drug Houses, Ltd.)

Diary of Societies.

MONDAY, JUNE 27.

ROYAL IRISH ACADEMY, at 4.15.

TUESDAY, JUNE 28.

ROYAL DUBLIN SOCIETY, at 4.15.—J. Wilson: Lord Morton's Quagga-Horse Hybrid: Was it a Hybrid?—J. Reilly and G. Fyne: A Modified Micro-method for Molecular Weight Determination.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. V. Gordon Childe: The Egean and the Danube Valley in the Second Millennium B.C.

WEDNESDAY, JUNE 29.

INSTITUTION OF MINING ENGINEERS (in Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne), at 10.30 A.M.—G. Raw: Notes on the Overhead Kriep Windung Plant at the Murlon Colliery of the South Hetton Coal Company, Ltd.—K. C. Appleyard: The Cleaning of Coal by Means of Pneumatic Separators, with Special Reference to the Sutton Steele and Steele Process.—W. D. Lloyd and Dr. J. N. Williamson: Experiments on the Reversal of Mine Ventilation.—Prof. I. L. Briggs, with an Appendix by Dr. J. Morrow: An Attempt at the Rationalisation of Pauling and Subsidence.—S. Walton-Brown: The Driving of Narrow Places.—J. I. Graham and A. Shaw: The Composition of Firedamp.—The following papers will be submitted for further discussion:—Miners' Nystagmus, Dr. F. Fergus; Miners' Nystagmus, Dr. J. S. Haldane and Dr. T. L. Llewellyn; The Construction of Flame Safety-lamps, Dr. R. V. Wheeler and D. W. Woodhead.

ROYAL SOCIETY OF ARTS (Annual General Meeting), at 1.

THURSDAY, JUNE 30.

ROYAL SOCIETY, at 4.30.—A. V. Hill, K. Furusawa, and J. L. Parkinson: The Dynamics of 'Sprint' Running.—A. V. Hill, K. Furusawa, and J. L. Parkinson: The Energy used in 'Sprint' Running.—T. S. P. Strangeways and Honor B. Fell: A Study of the Direct and Indirect Action of X-Rays upon the Tissues of the Embryonic Fowl (communicated by Sir William Hardy).—R. G. Cantu and F. G. Spear: The Effect of Gamma Irradiation on Cell Division in Tissue Culture *in vitro* (communicated by Sir Frederick Andrews).—And other papers.

Röntgen Society (at Royal Society of Medicine), at 8.—Sir Humphry Rolleston, Bart.: Protection and Other Radiological Problems (Mackenzie Davidson Memorial Lecture).

INSTITUTION OF MINING ENGINEERS (in Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne), at 9.45 A.M.

FRIDAY, JULY 1.

GEOLOGISTS' ASSOCIATION (at University College, Gower Street, W.C.1), at 7.30.—Sir John S. Flett: The Geology of the Edinburgh District (Lecture).

INSTITUTION OF MINING ENGINEERS (at Newcastle-upon-Tyne).

SATURDAY, JULY 2.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Western District Meeting) (at Town Hall, St. Anne's-on-Sea), at 10.30 A.M.

PHYSIOLOGICAL SOCIETY (at Oxford).

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Provincial Meeting at Royal Alexandra Hospital for Sick Children, Dyke Road, Brighton).

CONFERENCE.

JUNE 30 TO JULY 2.

NATIONAL ASSOCIATION FOR THE PREVENTION OF TUBERCULOSIS (at British Medical Association House, Tavistock Square, W.C.1).

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Newtonian Time Essential to Astronomy.*

By Sir JOSEPH LARMOR, F.R.S.

"Let us now praise famous men."

THE HISTORICAL PROBLEM.

WHEN Newton undertook the unprecedented task of exploring the dynamics of the motions of the heavenly bodies, sparsely scattered in the vast depths of cosmical space, the preliminary and novel problem in front of him was naturally to settle their bearings. He formally established the principle that, though there may be one essential space, or æther, all spatial frames of reference are equally permitted in material dynamics provided their motion relative to this standard frame and so to one another is one of uniform translation. Thereby, for example, he was justified in referring the internal motions of the planetary system to the sun as if it were a fixed centre, although it is in motion with velocity then unknown: going even deeper, he showed how the apparent regular revolution of the directions of the stars could be proved, by experiment, to include them within the range of a frame of the dynamics constructed locally so as to be appropriate to the events on the earth as a whole.¹ But he curtly laid down the postulate that there is one universal reckoning of time. He even went on, in another context in more speculative vein, to assign to this physical absolute time a transcendental significance,² which has made it a battleground of philosophers from Leibniz onward. On these fundamental topics no degree of precision can be excessive.

The next essential progress in general ideas relevant to permitted frames of reference for dynamical science came from James Thomson, the engineer brother of Lord Kelvin, as late as 1884.³ He recognised that the totality of such permitted frames form an interchangeable group: he invented for them the name 'frames of inertia,' which has been recently supplanting the term Galileian co-ordinates introduced in the relativity theory. He even propounded the fundamental question: given three systems of bodies in independent motion in the same space, under what conditions is it possible to discover a moving frame of reference in that space (and therefore a group of frames) relative to which their motions are all uniform translatable? The very idea of a frame of reference, as something requiring a name, seems to have

originated with his direct and acute, but sometimes tedious, thought. He recognised the problem of simultaneity, but could not solve it: that had to wait for the modern group-theory. About the same time (1870) C. Neumann published discussions, that attracted far wider attention, in which motions are framed by being made relative to 'the body Alpha.'

In the higher theoretical astronomy rotating frames of reference have however been practically in use ever since Newton, but more formally since the brilliant initiative of Euler in referring the dynamics of a rotating solid body to itself.

The simplicity of the Newtonian frames of space and absolute time was disturbed practically, by the fact that our celestial knowledge comes by rays of light which suffer delay in transmission. Principles of correction, taking cognisance also of the motion of the observer, were introduced by the great practical astronomer Bradley, during Newton's lifetime, which have remained adequate until this day.

But close tests on the propagation of the light itself, initiated by Michelson (1881) after an idea broached by Maxwell, indicated that things pass as if the velocity of light were practically the same absolute constant within all local environments, unaffected by the directions and magnitudes of their convections through space. This result, then unexpected and even paradoxical, became the stimulus to modern projects of complete local relativity, based on a general postulate (1900) that each local scheme of events is, so far as relates to the atoms of matter, self-contained. Its theoretical proof, up to the second order of approximation even within the atoms if only their structure is electric, rested on a principle of correspondence which had in Lorentz's hands already (1892) given an easy explanation of the aberration of light and other first-order effects. Such theories, necessarily only approximate for application within the atoms, culminated in impressive practical form (1915) in the inclusion of gravitation by Einstein, leading to his astronomical predictions and their subsequent verification.

The confirmation (1919) of Einstein's prediction of the deviation of rays of light in the sun's gravitational field, at once placed these later developments of the dynamics of relativity in a privileged position, and made their critical study imperative. Later the eclipse result has been enhanced by a gradual consensus of expert opinion regarding the alleged gravitational influence on the atomic periods of free vibration: but the original close

* Communicated to NATURE early in February 1927.

¹ Cf. the weighty scholium at the end of the *Definitiones* in the "Principia," where Newton lays down the necessity of a formal foundation of *Axiomata sive Leges motus*.

² Cf. the condensed theological metaphysics of the final *Scholium Generale*; also the Queries at the end of the "Opticks."

³ *Proc. R. S. Edin.*: "Collected Papers," pp. 379-403.

explanation, by the theory, of the outstanding small residue of the advance of planetary perihelia has become less cogent on account of uncertainties of the astronomical problem.

COULD ORBITS BE ISOLATED GEODESIC CURVES ?

These predictions all rested on a postulate that in a planetary system of orbits, as represented symbolically in an Einstein-Minkowski fourfold continuum, each gravitational orbit is separately on its own account a quasi-geodesic curve, like a line of shortest length. But it has been held (1922) to be intrinsically impossible to reason on the basis that the warping of this auxiliary fourfold continuum is determined by the representative orbits within it, while at the same time each orbit is determined by the warping of the fourfold. The influences have to be treated as mutual: the necessary intrinsic invariance of Nature, holding amid all the accidents of arbitrary modes of reference, which at first pointed to the geodesic postulate as a suitable choice, must thus belong, as the invariant Hamiltonian Minimal Action does in the actual dynamical astronomy, to the system as a whole, not to the orbits separately. When, however, the orbital problem was examined⁴ in the representative fourfold on this basis of a single mathematical Action function, originating in a field-Action, binding into a unity all the mutual influences, it appeared that the constant of gravitation had to enter into the expression for the Einsteinian absolute symbolic interval of fourfold space-time in the form γ instead of 2γ , leading to smaller potency of gravitation on light so that the two predicted optical effects of gravitation must each be halved.

The only criticism of this result of which I am aware was a remark to the effect that, if this is really so, then there must be something wrong with the application of the method of Minimal Action. Yet that method has continued to be, without substantial modification, the essential and eminently convenient foundation of the general fourfold mathematical theory of relativity. The astronomical verifications in agreement with the Einsteinian values, as they became generally accepted, have thus pointed insistently for several years to the necessity of finding some way of reconciliation of this alleged fundamental discrepancy in the theory. It was indeed clear enough that the rôle of astronomical time in the formulæ, as taken over from Einstein's own adaptation for his geodesic postulate, was unsatisfactory; but nothing better presented itself, though a slight error here involves great consequences. Various attempts at reconciliation, essayed by the writer during the last four years, have shown themselves inadmissible. It is easy, for example, to solve the problem, which is simply that of fitting gravitation within the domain of the optical and electrical relativity postulate, by means of a scalar potential of gravitation, introduced alongside the fourfold vector potential that is the expression of the electric and optical field: but

that course, otherwise apparently unexceptionable, does not suggest any interaction between gravitation and light. Thus the actual astronomical detection of such an influence, as stimulated originally by Einstein's formulation, and carried through in the first instance in eclipse expeditions guided by Davidson and by Eddington with the help of the Astronomer Royal in the preparation, has now come to control the whole discussion in its own right.

DYNAMICAL TIME INHERENT IN THE INTRINSIC STRUCTURE OF MATTER, NOT IN FORMAL FRAMES.

The reconciliation of this discrepancy that will now be put forward is held to place the modern mathematical theory of relativity on its intelligible physical foundation. An actual astronomer is not an isolated solitary flying particle of the abstract mathematical theory. In his annual journeys at high speed round the extensive circumference of the earth's orbit, he takes his instruments and his landscape of reference along with him, without which he would be helpless: more important still, he takes his astronomical records extending over centuries of time, which have to be permanently intelligible and consistent to all brother astronomers, actual and potential, at all times and all places and moving in concert with their environments with all conceivable speeds. There must be something of the absolute involved here. The solution now offered is that our astronomer's own local space and time are absolute Newtonian space and time: that, unless we turn back from and reject the whole *corpus* of modern spectroscopic atomic doctrine, it is not possible to wriggle out of Newton's *dictum* of the necessity in dynamics of a universal continuous measure of time. Nor indeed do the creators of modern relativity attempt to do so, except in so far as many of them have become uncomfortable under the Einsteinian universal invariance of the time-space auxiliary fourfold interval, which as here interpreted involves and even imposes absolute time.

In the Einsteinian form of fourfold Action it is the modification of the time-like variable that dominates almost completely, as regards the actual universe with its slow motions, the forms of the symbolic tracks, because t enters into ds in the form cdt : when we have learned how to transform the symbolic track into an actual orbit in space and time with close accuracy as regards t , a much more rough adjustment will suffice spatially. Hence the importance of the utmost precision in the time-specification.

The extension of the environments of the astronomers, as enshrined in frames of the local standard, or so-called natural, space and time universal in character and the same for the environments of them all, into wider regions, is troubled by the fact that their only practical means of distant communication is by rays of light or other electric signals, which are delayed in transmission and affected by the motions of the observers. As regards astronomical observations that difficulty was discovered and surmounted

⁴ *Philosophical Magazine*, Jan. 1923, pp. 243-256.

as early as 1727 by Bradley, who, especially by his fundamental principle of aberration, founded and even perfected the science of practical astronomy. But not merely an approximate practical consistency; an absolute mathematical fit is required, though possibly of a kind which may never attain to verification, if the accumulated work of astronomers is to be intelligible in ideal completeness to intellectual scrutiny, notwithstanding every variety of position and motion of possible observers and recorders and the complexities of light-transmission, of all which complications an ideal foundation for the records of astronomical history must in theory take exact cognisance.

It is held that the demand for universal intelligibility thus introduced, though of a generality which transcends any special *corpus* of physical science and so may appear at first sight to be unfruitful as being metaphysical, does point to a necessary and attainable actual construct within this domain of knowledge, that of astronomy and physics. Knowledge is rendered possible because, though the intrinsic times of all observers everywhere have to be identical because the local atoms are absolute in relation to their environments, yet the epochs or origins from which these times are measured in the various localities do not come into consideration at all, only intervals of time being concerned in the astronomical dynamics. It is this indetermination *à priori* of epochs, in conjunction with the absorption of all possible conceptions of local frames into simple invariance of the fourfold interval, that confers the requisite flexibility, permitting all the identical local reckonings of space and durations of time, of all observers everywhere in all ages, to be consolidated precisely within one wider auxiliary conglomerated fourfold scheme of mathematical representation.

The course of an astronomer's life, by the interpretation here advanced of the natural demand for relativity, works itself out of necessity under the sustaining local influences, is relative to his sub-permanent natural surroundings — this being indeed a type of postulate already recognised in mathematical form for similar reasons in the more minute cosmos of the atomic theory of elastic bodies. Our astronomer thus cannot know whether his environment is careering through space or not; that question must be meaningless to him, except so far as it is opened out by probable inference from the messages coming to his marvellously adapted sense of vision by light from the distant regions of the cosmos. In any case it is only his local smoothed-out frame of convenient reference, in which the occurrences that affect him are set, that can in any scheme of feasible simplicity thus be regarded as careering through space. He can and does construct his own Newtonian dynamical science of the motions observable within his local frame, often involving large relative velocities, even including local so-called centrifugal forces; and he could do this effectively though with far more trouble without calling upon light at all, just as if he and his associates were blind. Unless indeed the motion of the suitable local frame

relative to adjacent permitted frames proves to be so erratic as to involve conspicuous differences of speed in its own adjacent parts, such as are called rotation: and then the remedy is to reduce the importance of the rotation, as can be done by increasing, by subdivision of frames, the fineness of the meshes of the analysis, so diminishing the extent of the local landscape which is the differential element, effectively uniform, with which a quasi-geometrical theory operates. Rotation of frames of reference, modifying velocities to an extent depending on the effective radius of the frame, appears on this view as a secondary and avoidable feature: in illustration, the rotation of the local element has added no term directly to the usual dynamical equations for a differential element of volume of a strained elastic solid.

The fact that the Lorentz transformation has to relate to convection without rotation is thus not now a harmful restriction. Moreover, on our view the influence of rotation can in any case be confined within the local frames, for it can be taken to belong to the dynamics of the bodies in the frame and not to the frame itself: a law of centrifugal force need not now belong to an unlimited frame and so extend away in increasing intensity, to be compensated at infinity. The original Newtonian argument from a spinning bucket, or in equivalent actuality the Foucault pendulum or gyro-compass, can demonstrate with the aid of light that the relative invariant property expressing fixity of gyrostatic directions within the frame, which the internal local Newtonian dynamics involves and can discover locally in self-contained manner, does actually extend outside as far as the fixed stars, which thus prove to be included within the region of spatial extension over which the play of physical theory is effectively Newtonian or uniform.

The directional fixations, unlike time, are thus local, not absolute; and the relevant question is, how far does the frame, for which they can be taken practically to subsist, extend: thus removing an insistent but, like unbounded centrifugal force, an unnecessary absolute. Or conversely, if we adopt as the expression of the natural notion of relativity, this idea that the convenient frames of reference of dynamics cannot be expected to extend uniformly to infinity or further than they can be tested, it points naturally towards trying a variable continuum, in which indirectly, as one may even say, Einstein discovered a suitable symbolic representation for an invariant gravitation. On the other hand, our immediate personal domain of local dynamics of matter can be so small that optical relativity merges practically in Newtonian relativity, the delays and other complications of light becoming negligible: but there is nothing to exclude another wider uniform frame, regarded as fitting across it, whose contents may be when so desired referred to it instead of their own frame, by aid of the Lorentz transformation which conserves the optical invariance all over it. This is the essential feature emphasised here, that the relations of pure relativity are concerned only with the specifications of localities in space and time,

and prescribe the modes of adjustment and continuation of the group of the permissible local frames of reference: that the mutual dynamics of the masses existing in each local frame proceeds independently by Newtonian principles, if, as in Nature is actually the case, they arise in a landscape practically permanent as regards the larger features each within its own most convenient frame.

For example, on this formulation of the natural notion of relativity, an astronomer will be under no temptation to undertake a violent journey through the cosmos in order "to return on the previous night" as has been said and so rejuvenate the activities of his life, any more than he will be tempted to go to the antipodes in order to stand on his head.

Only relations are directly accessible to our knowledge, and in this domain most conspicuously of all. No progress has yet been made, any more than in Newton's day, in unravelling the essential nature of gravitation. No reason can be assigned why it is just as intense as we find it, or why it exists at all. What can be established by the Einsteinian verified predictions is that, being in some unknown way an essential feature of the physical universe, it does fall into line, as one had anticipated that it ought to do, with electrodynamics and optics in obeying the principle of local relativity, the regional self-containedness of local material phenomena, as above elaborated.

DYNAMICS IN A TWO-DIMENSIONAL COSMOS.

The analogy, and contrast, drawn from the Gaussian intrinsic geometry on a surface of variable curvature, by which these beautiful recent developments in a fourfold mathematical theory of universal relations in space and time were doubtless suggested, can be pushed a considerable way in this direction. We consider now not an individual explorer, but a whole population, whose activities are confined close to the surface on which they subsist, their thin cosmos of which alone they are conscious. Each community have their local world of events occurring in their local landscape on this sheet, and may construct, with a view to express the orderly succession of these events, their own local science of dynamics and physics. This science is conveniently laid down for each of the groups within a local frame of reference, which is flat or Euclidean, and can be envisaged as a uniform reference-lattice of straight lines; also in a local scale of time regarded abstractly as flowing uniformly, while determined practically by the prominent uniformities of recurrence in their phenomena. But when their region is extended too far, a misfit in their simple scheme rapidly develops; for the surface of their activities curves round, as we outsiders know but the inhabitants do not.

A theory of a wider cosmos cannot, however, arise at all unless the local populations possess some means of communication with one another. Let us consider a forest of threads stretched tight over their surface, and imagine that messages can be transmitted along them from each group to the others: these threads are so far the analogues of

our suitable paths for transmission of rays of light. Without them, all these local frames of flat geometries and their related dynamics in natural time would subsist, but in isolation; without a very refined use of them there could be no kind of relation established between standard axes defining the expression of directions, in any two of the local regions, just as there is no overt relation between the epochs of the absolute times in our local regions also internally self-contained. But such inter-connexions can be worked up for them by constructing an auxiliary universal geodesic geometry (for example, spherical trigonometry) resting for its expression on the stretched threads, a conglomerate scheme which includes and also sums up all the local geometries. Though unbounded for them, it may even be restricted essentially, unknown to the inhabitants, to a finite, even possibly cyclic, domain as a complete frame for their cosmos, if the surface expressing our external, but to them abstract or symbolic and difficultly explorable, frame for the expression of their experiences closes up like an ellipsoid or solid ring: thereby relieving essentially the indetermination of the infinite. Their local plane geometries are here implied, that is, are postulated, to be all identical in type and scale—also their local experiences to be of the same type and therefore the time in which they are naturally set—that is, they are absolute in their dynamics.

This type of scheme involves, and is secured in its widest generality by, the analytic postulate, after Gauss and Riemann, that the squared interval of length on their surface, expressible as a quadratic function of the differentials of any two functions defining any lattice of co-ordinate curves determining position on the surface, is transferable all over it without change of value after the manner of a terrestrial surveying chain, is in fact mathematically invariant and absolute. Yet really all that our present science of differential geometry is usually capable of dealing with is gradual transfer, explored step by step on the basis of local differential equations. Here the rays of light are more potent than the threads or the geometry, for they can translate directly a finite interval of time, expressed in absolute atomic periods, across an almost unlimited range in the cosmos.

This is something beyond geometry, which imposes itself on the formal pseudo-geometric continuum determined by the postulated fourfold invariant interval. This latter, as already remarked, is able to create the fourfold scheme, because it can condense local frames, with all speeds of convection, within one element. How far this extraneous physical feature, the presence of light, tightens up the pseudo-geometric scheme we do not now stop to inquire; except to remark that it accentuates the absoluteness of time, as *sui generis*, already suggested and indeed provided for by the different sign of the relevant term in the expression for the quadratic interval itself. Nor will we consider the more recent problem set by Weyl and Eddington and followed up by Einstein, which really is how far a much wider type of frame for events, imposing

only local relation between vector displacements of points, can be constructed so as to involve in itself, be consistent locally, and beyond by continuation, with the different and more tangible kind of foundation provided by postulation of invariant intervals such as distance—for it would seem, as has been already remarked, to be too loosely hung together to be identical with a geometric frame even combined with an arbitrary electric field, though such frames may well subsist inside it.

OTHER ELUCIDATIONS AND CONTRASTS.

There may be some instruction also in an analogy of our Newtonian Absolute Time T with the Kelvin Available Energy, A , in thermodynamics. At each temperature of a material system under discussion, intervals of A are measured as definite amounts of absolute energy; which is in fact the essence of the perpetual-motion postulate of Carnot, there the analogue of the present one of a local absolute time. But in passing to a different temperature of the material system the origin or epoch of measurement of A has been lost, and it becomes necessary to include A as a feature in a wider auxiliary theory, introducing a new and universal formal quantity, the entropy of Clausius, in addition to energy and of different essence. But alternatively we can usually do without any such general scheme by relying, as is familiar in special problems, on special isolated cycles of change resting directly on the Carnot-Clausius principle, our general knowledge of Nature supplying the relevant foundation—just as here we might perhaps reason directly on the relations between the local Newtonian frames instead of merging them in the one fourfold consolidation which their law of mutual correspondence permits.

We may also perhaps illustrate in another different manner. The pseudo-spatial construct of Einstein-Minkowski has given us an inkling as to how the cosmos of discrete events in history may be laid out, as it would be present to the sensorium (to adopt Newton's term) of a divinity who would have knowledge of all occurrences, but necessarily in an incoherent manner; for coherence is foreign to direct awareness of the totality of things, being the compensation permitted to imperfect knowledge, to some degree artificially and arbitrarily, by relating the succession of events in some kind of co-ordinated fourfold index, or frame, of reference. This gradual development of coherence in the range of our experience in space and time, which is scientific method, must run into some calculus of representation, in this generalised problem provided by the multiple algebra of tensors. The mathematical theory, brilliant as it is, soon indicates that this consolidated point of view, apparently losing all distinction between past and future, would transcend human intellectual ability to develop, except in its very rudiments; at any rate until mankind have learned to deal with a formal pseudo-space in four dimensions with the same intuitive familiarity that they now cope with ordinary space in three dimensions.

On the other hand, the actual science of

astronomy is an affair not merely of going on "observing coincidences of point-events" in the heavens, but of accumulation of coherent records extending over centuries, permanent human documents in which all the new observations must find absolutely consistent places. There can be no science without memory and without records. For it to be humanly feasible to find out, for example, from minute discussion in the long-continued records, whether there really is a very small residue, unexplained by Newtonian theory, in the precession of the apse of the planet Mercury, must demand, if even only as a practical measure, some definite way of reckoning duration that is independent of the accidents of place and time and motion of observers; just as the instinct of Newton briefly postulated. And when in the setting out of a timeless cosmic history in a fourfold transcendental scheme, our special human knowledge, in space and time, acquired in marvellous manner from the advance of optical science, that an atom say of hydrogen must be taken to be intrinsically the same whether it be in a seething star or on the earth, so is absolute, obtrudes itself into this hitherto merely abstract historical spread, and demands, what is indeed a very small fraction of what it involves, an absolute universal (Newtonian) time for itself in its own material environment, determined by its own permanent vibrational properties, science must eagerly grasp at this revelation as in fact bringing the Promethean fire down from heaven, and rendering, as the philosophers say, human knowledge possible in this domain.

If the present course of argument is valid, the essential proof hitherto that this inference from the absoluteness of the atoms is in fact the right one, is just the confirmation in actuality of the Einstein predictions as to the gravitational influence on light, especially on the period of vibration, which, as one has been forced to hold for the last four years, would otherwise rest on a foundation largely accidental. Without that direct astronomical verification, insistence nowadays on absolute local times might well seem an anachronism.

If we could contemplate history like gods, looking equally before and after, generalised matter and energy might conceivably present themselves, as the elaborated mathematical representation in the fourfold implies, each as a tensor having as many as ten essential components: and they might be perhaps within limits identical and interchangeable. But within the frame of structure of the absolute standard thought that is valid and exchangeable amongst the human race, there have been at length recognised these wonderful absolute atoms existing as matter in their own rights without any sign of ageing or decay, being still in Maxwell's phrase "the foundation stones of the material universe"; and there has also been gradually acquired an idea of conserved energy which it has been useful to postulate as likewise universal and fundamental: and these two stand out as independent features of the foundations on which physical science builds; though related by the circumstance that the electric field belonging

to an atom is proved mathematically to add to its inertia, otherwise naturally an absolute possession, by virtue of the energy of that field.

When two atoms approach and, by overlap of their fields, release in the form of radiation some of these intrinsic field-energies then partially superposed, a proportionate part of the inertia of the atoms goes away along with it, subtracted from their translational energies when the atoms become separated again unless indeed they have suffered permanent internal change in the process. This works out consistently: energy of electric activity, even of free radiation, carries inertia with it, and thus carries momentum too. But the assertion that the whole of the mass of an ultimate atom is energy would remain a barren though permissible⁵ figure of speech, unless it means to assert a postulate that mass is somehow practically all separable electric and other field-mass arising from *motional* energy of merely formal nuclei with separable æthereal fields. This would compete with the idea of an electron as a field of *static* strain-energy essentially and irrevocably locked together around a centre. A development by Minimal Action, as indicated in what follows, can provide room for both kinds of mass, the intrinsic and the exchangeable, within the postulate of absoluteness of the atoms.

GRAVITATION REMAINS UNEXPLAINED.

The original case for the postulate that orbits are separately geodesic curves in the gravitational auxiliary fourfold was based, very forcefully, on the Newtonian identity of mass and weight, which otherwise remains a challenge, as an unexplained universal feature of matter. According to the marvellously precise results of Eötvös, working with his modification of the Michell-Cavendish torsion-balance, the force of gravity is found to be the same per unit inertial mass as exerted on all kinds of matter, this being actually verified beyond the order of 10^{-7} which is nearly as far as the order of the observed optical and electric relativities, namely 10^{-8} . If we reason on the basis of the Faraday type of concept, thinking however of a pre-ordained unchanging field of gravitational activity, then a collection of bodies composed of various kinds of matter move down the field in company, though with acceleration, not separating if they start with the same speed, almost as if they drifted in a current of fluid. If this field of gravitation is interpreted as merely a warp in a frame of space and time, this would naturally be regarded as a modification of the inertia which makes every free body describe, after the manner of Newton's First Law of Motion, on its own account alone, a representative path in a space-time auxiliary fourfold, determined by the purely quasi-geometrical property of minimal intrinsic quasi-length: and that is the gist of the geodesic postulate. But the other side of this consolidation of inertia with amenity to gravitation presents itself, when we reflect that a field of gravitation can vary, and so should have an assignable origin: which Newton found in an influence emanating from

all the masses in the field, yet of a type of exceeding simplicity functioning just as if it were simple attraction according to his inverse-square law.

The Einstein mathematical theory can determine, at any rate as here amended, by self-consistent algebra in an abstract space-time fourfold extension, as a domain symbolically enshrining paths and masses of the bodies, a warp which proves to be necessarily restricted to a special type—just what is needed to represent gravitation. It has still to assume, however, after Newton and without explanation, that the mass which operates in this different function, that of creating the field, also is identical with the inertia mass. One may indeed reply that the geodesic postulate says nothing about mass: but it does determine a track along which the entity that determines the gravitational warp of the fourfold continuum is distributed, much as a magnetic field is determined by the tracks of electric currents,—a track which as above cannot be both direct cause and direct effect.

Though indeed the direct astronomical evidence to verify this identity of attracting mass with inertial mass may not as yet be very exact, the principle reposes firmly on a basis of its own, different from that of the Newton-Eötvös result; namely Newton's consideration that the accelerating influences between two masses rigidly connected together must be exactly balanced if motion is not to increase spontaneously without limit and so destroy any steady order of Nature. The argument from Eötvös carries only part of the way: this Newtonian doctrine of conservation of momentum is essential as well. But the latter is mutual dynamics of bodies, rather than geodesic geometry of an isolated track in a warped pseudo-space. It involves mutual relation between all the bodies in the field, bodies which also create the field: and this concurs with the previous conclusion that the path of each single body can hardly be regarded, except by an argument moving round in a circle, as a minimal inertial track in a continuum which that track itself has a share in modifying or even creating.

A study, in the light of this point of view, of the crisp exposition of principles in the first four sections of Einstein's earliest formal exposition of 1916 shows how easily it could have been turned round into the present direction. His 'natural' or absolute time, here adapted into the forefront of physical theory, is there practically put away in favour of a fourfold variable, transcending space and time,⁶ and necessary to the auxiliary algebraic tensor theory, which is no more time than entropy is energy. It was natural in advance to presume that the symbolic path of a body, at any rate of an infinitesimal particle, was expressible as a minimal inertial track as if in a pre-determined continuum, until it appears as here maintained that this could not conform to actual gravitation as one mutual force between two bodies.

⁵ It seems to have imposed itself originally in a very interesting exploring discussion, 'on the influence of gravitation on light,' *Ann. der Physik* (1911), § 3, English translation, p. 105, prior to the opening out of the general problem.

⁶ But only up to the second order.

The discipline known as the mathematical theory of relativity would on the present view become a condensed census of the mutual necessary relations of the group of permitted frames of reference, in which investigators variously situated in space, time, and motion may conveniently and consistently formulate the physics of the local worlds, of infinite variety, to which they belong: but the cosmos is far more than its frame or even than our most far-reaching yet still superficial analysis of it within that frame.

It is a modified Newtonian physical foundation that has here been summarily set out. After all, if the present view justifies itself, it will be no derogation to the brilliant scheme of mathematical co-ordination of the general relations of gravitational and electric fields worked out by Einstein, and indeed not pressed by him (originally at any rate) to any transcendental issues. And on any view we have to admit that gravitation, like the great bulk of therational exact principles of uniformity discovered by science in Nature, physical and biological, still in essence continues to lie beyond our scrutiny.

RELATION OF ABSOLUTE TIME TO THE AUXILIARY FOURFOLD HYPERCOSMOS.

It is becoming widely recognised—it seems now to be Einstein's own considered opinion—that an absolute transferable interval of space-time, the analogue of a universal measuring chain, cannot be avoided, however eager be the quest for an unconditional relativity of physical knowledge. It is here maintained that the difference in sign gives the time-element a footing independent from space in that symbolic absolute interval: in a sort of analogy to this, the general fourfold invariant tensor has been recognised recently as involving fundamentally, for the abstract relativity theory, two independent tensor *data*, a symmetric one and a skew one. When absolute time is thus taken out, the remaining part of the interval, giving the foundation for spatial determinations, is to be associated with an absolute lattice-frame locally uniform or Euclidean.

The pseudo-spatial auxiliary fourfold continuum of Einstein is made up by fitting together, so to say by dovetailing, the sub-groups consisting of all the local convected frames of reference (frames of inertia) which are suitable to enshrine the local Newtonian dynamics of ordinary experience belonging to the various environments in the cosmos. These variously convected local frames of reference, adapted for each domain of experience, but all condensed into one element in the auxiliary fourfold, which is effectively differential in the sense of differential geometry, may be presumed, in the search for a *locus* for gravitation, not to fit together into one universal group symbolically extending over the whole fourfold pseudo-space, without some straining of each of them, such as would cumulate sensible effects at places further removed from the centres of their localities. An essential feature is that this warping is here put on the frame, in preference to an equivalent warping of the laws of the local Newtonian dynamics that the frame enshrines. It is now well recognised

that it might be put on either: the frame might be taken to be absolutely uniform throughout the universe, at the cost of complicating the expression of the experience formulated within it.

The essence of relativity as a practical proposition is that a scheme of knowledge is relative to some suitable frame of reference: it may be a matter of facility of exposition how much of universal relations is put into the frame, and how much is treated as belonging to the local dynamics of the system of bodies whose phenomena are referred to that frame. This is the key to the present treatment: everywhere there is the convenient frame of reference: it is relative to that basic frame, not to one another, that the local events are most simply and concisely expressed: such local frames, convenient and practically indispensable, have to be grouped together, consolidated into one compound scheme in order that scientific knowledge gained in the locality, in space and time, of one of them should be transferable into the localities of the others. That becomes possible, because all local frames, however differently convected, can be consolidated within one element of the fourfold by the Lorentz transformation, so that, the convolutions being thus disposed of, only space-time distributions remain to be fitted together, by strain if that proves to be necessary for the convenient expression of Nature.

The choice, however, of the local frames has here developed into more than a matter of convenience. The thorough absoluteness of the symbolic Einsteinian interval, involving, as here asserted, absolute time as well as a universal measuring chain for all local spaces, now working in concert with the marvellous practical instrument we have come to possess for exploring material systems far outside our own dynamical environment, allows us not indeed to envisage directly the universal symbolic composite frame which subsumes all the actual local ones, but to carry through experimental tests for the formal validity of any attractive mathematical representation thereof that we may be able to contrive. The rays of light enable us actually to transfer directly the intervals of t , one of the fourfold auxiliary set of co-ordinates in this composite universal frame, being that one which is more specially related to time, from one part of the universe to another.

The differentials (δt) of this co-ordinate that are associated with the ray-pulsations stand locally in connexion with intervals of absolute time (δT) which are intrinsic for all environments, by a relation that may involve local gravitation among other things: it is the spectrometer that can provide the test whether this constructive process for communication with distant systems is in actuality verified,—and that in a way that Newton could hardly even have imagined. First the absolute period of vibration (ΔT) of the solar hydrogen atom is to be transferred into an equivalent interval $\kappa \Delta t$ ($= \Delta T$) in the universal auxiliary co-ordinate t of the minimised fourfold; then the very same absolute period, namely ΔT , of a terrestrial hydrogen atom may be observed,

and also can be transferred into the equivalent interval $\kappa'\Delta t'$ expressed in this co-ordinate t by the ratio κ' appropriate to terrestrial instead of solar environment; thus giving $\kappa\Delta t = \kappa'\Delta t'$. As it is the auxiliary period Δt that is transmitted by undulation along the ray and received into the spectrometer, that instrument functions *as if* it were measuring directly two different actual periods $\Delta T/\kappa$ and $\Delta T/\kappa'$. For vibrating atoms at rest in the solar frame $\kappa = (1 - 2V_s/c^2)^{1/2}$ where V_s is the gravitational potential of the sun: for a terrestrial atom κ is practically unity. This agrees with the Einstein prolongation, now only *apparent* not intrinsic, of the periods of the solar radiation. If the atom were moving with speed v in the solar frame of reference, instead of being at rest, the Lorentz transformation as *infra* would seem to impose another factor ϵ^{-1} or $1 - \frac{1}{2}v^2/c^2$, on the period, which is in the opposite direction but wholly swamped by the Doppler effect.

This feature, that every interval Δt is conveyed without change all along the representative ray-path of the auxiliary fourfold, is based on the nature of the undulation along a ray; it rests in theory on the circumstance that the electrodynamic optical equations, as transferred into the invariant form inherent in this composite fourfold ($xyzt$), are satisfied in undulatory manner, not exactly but to adequate approximation, by making the variable t enter in the expression of the solutions only through a universal periodic factor $e^{i\omega t}$. It is the absoluteness of the hydrogen or other atom, steadily maintained through all vicissitudes of place and motion even doubtless of acceleration of its environment, referred to its own frame that accompanies it, for which internally the translatory motion means nothing, that provides a universal natural measure of an absolute flux of time T , namely that of any one of its intrinsic types of vibration: it is the spectrometer alone that in quite recent times has become available to extend our local dynamical experience practically and directly into a universal scheme of intervals of time everywhere absolute, such as is involved symbolically in the universality of the Einstein space-time measuring interval.

In terms of universal Newtonian time thus acquired, the permanent results of astronomy have to be expressed: for its accumulated records must be in accord with the local measuring appliances, pendulums, gyrostats, marks of local direction, position, etc., on which observers wherever they be in space and time and however convected have to rely. This postulate of local frames of reference in space and time, enshrining their material dynamical contents, everywhere Newtonian and absolutely identical just because dead matter and its manifestations are presumed to be identical in type everywhere, is already latent in the preconception of a *continuous* differential geometry applicable to the fourfold: that the frames can be thus consolidated therein, conveniently and manageably to sufficient approximation, along mathematical methods such as the one that Einstein has opened out, is from

the present point of view consistent with our fundamental requirement that as knowledge proves to be possible and enduring, the modes of its acquisition and record by all potential observers of natural phenomena, however variously situated in the cosmos, must be consistent among themselves.

THEORETICAL COHERENCE IS ENSURED UNDER LEAST ACTION.

It remains to indicate briefly how these ideas modify essentially the mathematical analysis and its interpretation, without unduly disturbing Einstein's famous three tests, postponing for the present other issues that incidentally arise.

We base the whole development, after Einstein, Hilbert, and Lorentz, and recently Whittaker who has attempted a striking electrodynamic generalisation, with ideal security and simplicity, on one invariant scalar integral, extended over the fourfold conglomerated representative continuum in which the symbolic history, past and future, of the cosmos is spread out, namely,

$$A = \int (G + L + \lambda) d\tau.$$

That integral is the closest available analogue, in this mixed ($xyzt$) continuum, of the Action integral of Lagrange and Green framed in ordinary space with independent time, as applied to develop the laws of undulatory disturbance whether in a continuous elastic material body or in an æthereal optical medium. Here L is the analogue of the Action-density of the elastic or electric field; λ is a constant which may be needed to satisfy the restrictions of our point of view, the analogue of a pressure which was familiar in early optical theory as necessary to adjust across an interface undulations purely transverse like those of light, occurring in a medium supposed to be incompressible; G is a multiple of the Riemann scalar curvature-invariant which confers just the suitable intrinsic freedom when the basic fourfold is now contemplated after Einstein as non-uniform, while its element of extension $d\tau$ then involves the familiar scalar factor \sqrt{g} .

This formulation of a compound Action-density, which is to become expressive of universal dynamical history, is first to be minimised as regards its distribution, with reference to variation of structure of the fourfold pseudo-space, as in the end controlled by its material contents expressed symbolically by their historic tracks therein. This variation leads to structural differential equations of that fourfold, thus conferring on it a definite character of the Riemannian geometric type. Within the pseudo-spatial connecting structure thus established, the Action can now be integrated by parts, leading to boundary terms along with a different spatial integral: it may be that the spatial integral vanishes, and this will occur under quadratic conditions. The boundary for such integration in the fourfold consists, in an atomic theory, of the surfaces of very thin filaments enclosing the historic tracks of the atoms and electrons which alone are out of bounds: the boundary integral is reducible practically to line-

integrations along those tracks. The Action A may thus, on account of the structure of the field as already settled by its own variation, be expressible as made up of parts associated with the material system alone as represented by the historic tracks of the atoms or finite masses. It is now to be further minimised⁷ with respect to variation of these historic tracks, that is, of the representation of the history of matter: that will lead to the expression, suitable to the fourfold, of the dynamical equations of interaction of the atoms, in fact to a *symbolic* dynamics of the matter that is present in the field, now latent, which itself arises from that matter as nuclei or mathematical singularities of suitable type, in accordance with the laws determined by the previous variation in the field itself: all this mutual complexity being held firmly in check by its origin from a single Action formula.

THE GUIDANCE OF CLASSICAL ELECTRIC THEORY.

This process is directly suggested, and has even been guided, by cognate Maxwellian electric theory:⁸ the special case of a system of linear electric currents in space affords a close analogue of the historic linear tracks of atoms. In that theory the energy of the currents—there a kinetic part T and a potential part W —is postulated to reside, possibly as strain and motion, in the dynamical field of the interconnecting medium or æther. An Action-density L in this medium, or kinetic potential $-L$, is formulated analytically, being equal to $T - W$. The Action $\int L d\tau dt$, $d\tau'$ being spatial, thus expressed by local elements, is minimised over all the field, thereby adjusting the electrodynamic field to a coherent structure, presented in the form of its Maxwellian absolute circuital equations. With this field-structure, so determined, the energy, and the Action, become condensable into expressions in terms of the currents alone that are the sources of the field, in the form of line-integrals involving their circuits: the result as regards the kinetic part is represented by F. Neumann's energy formula, on Amperean lines, for linear currents in terms of the ancient current elements such as ids , namely a mutual energy

$$T = \sum \int \frac{1}{r_{pq}} i_p ds_p i_q ds_q \cos(ds_p ds_q).$$

Incidentally and more precisely, when the current is expressed in ultimate form as made up of electrons, the complete Action, as it has now to be, in form suitable to the fourfold, is

$$A = \sum \int \int \frac{1}{r_{pq}} (e_p dx_p e_q dx_q + e_p dy_p e_q dy_q + e_p dz_p e_q dz_q - c^2 e_p dt_p e_q dt_q);$$

for this form is invariant (except in one feature as regards r_{pq} which leads to a different story that would now carry us too far) and involves the two sets of independent variables (x, y, z, t_p) and (x, y, z, t_q) in the fourfold, expressing position of each pair of interacting electrons but not any one universal

time t . Reverting to Maxwellian theory, the forces between the bodies carrying the electric currents are then determined by further variation applied to the Neumann formula, now with respect to change of form of their circuits, in time, by variation with respect to position without further reference to the field, still in the background but already previously settled: and that in fact constitutes the Neumann energy-theory. If we wish to avoid specifications in terms of any concept of mutual forces, this process of minimising a scalar Action by variation can lead direct to the complete set of equations of motion of the conductors that carry the currents.

One essential point the analogy brings out prominently. It will not do, after Hilbert and most writers on this subject, merely to add some suitable invariant form of line-integral to the field Action A in order to express the interactions of the material atoms. The Faraday-Maxwell doctrine is that the energy, or in complete general dynamics the invariant Action, all resides in the field, there being no other; coherently, in that the field adjusts itself minimally to laws that permit this energy, other than free energy expressed as radiation, to be associated permanently with its sources, the atoms or electrons constituting the currents, and thus to be treated as belonging to them.

We have to determine what form the corresponding generalised Action, thus reduced to material form, ought to take in the fourfold problem. The Neumann formula suggests a double integral extended along each pair of the circuits or historic tracks. Under certain limitations (now postponed) it is reducible to a single integral, analogous to the Maxwellian kinetic form involving the electric potential ($FGHV$), namely

$$\sum \int e_p (F_p dx_p + G_p dy_p + H_p dz_p - c^2 V_p dt),$$

involving with Maxwell dt not dt_p . There arises also naturally here, in regard to the fourfold, a local part deriving from mutual activities of the nature of self-induction between the sub-filaments of the cylinder-track of the moving electron, which adds a term $\mu_p ds_p$, where μ_p is a constant expressive of the familiar electric inertia; this part is directly suggestive of the modified Einsteinian intrinsic inertial form now to be introduced, to which an electric part like the above is to be added as the reduced expression of electrodynamics.

PREVIOUS ANALYSIS BY ACTION REVEALED DISCREPANCY WITH FACT.

In the previous effort towards this type of gravitational theory, already referred to (*Phil. Mag.*, Jan. 1923), a linear form of integral was assumed for this reduced Action, as being the nearest analogue of the Einstein geodesic form which connects itself so readily with dynamical orbits. This restricted the choice to the only available type of invariant linear form, which is

$$A = \sum \int -cm_p ds_p;$$

where locally in each frame ds^2 reduces by suitable change of co-ordinates to the absolute intrinsic standard form $c^2 dT^2 - d\sigma^2$ where $d\sigma^2$ is Euclidean, while all over the fourfold it is expressed con-

⁷ This is not the procedure for determining *actual* orbits in space and time. This reduced Action has the requisite invariance, from its mode of formation: and it can now be transferred from the timeless fourfold into a frame in space and time as *in/ra*, when it becomes the ordinary dynamical Action of the planetary system as referred in space and time to that frame.

⁸ Cf. "Æther and Matter" (1900), Ch. vi, especially §§ 50-9.

tinuously in terms of universal co-ordinates by an invariant quadratic differential.

We now introduce the Schwarzschild expression for the spatial-gravitational field as modified by the symbolic track of a mass m moving with changes of its speed restricted to be very slow compared with the velocity of light, namely

$$ds^2 = c^2 \left(1 - \frac{km}{c^2 r} - \left(1 - \frac{km}{c^2 r} \right)^{-1} dr^2 - r^2 dt^2 - r^2 \sin^2 \theta d\phi^2 \right).$$

Or better for the problem of several interacting planets, the earlier but less exact Einstein expression

$$ds^2 = c^2 \left(1 - \frac{km}{c^2 r} \right) dt^2 - \left(1 + \frac{km}{c^2 r} \right) (dx^2 + dy^2 + dz^2),$$

which is spatially isotropic and so adapted to superposition of disturbing influences. Our direct immediate concern is the question whether, in order to express gravitation within the scheme if that proves to be possible, k must be identified with its absolute constant γ , or with 2γ , the first alternative halving the gravitational effects on light as originally predicted. With sufficient accuracy for this purpose we have for the field of a system of planets the collective isotropic form

$$s_p = c dt_p \left\{ 1 - \sum \frac{km_q}{c^2 r_{pq}} - \left(1 + \sum \frac{km_q}{c^2 r_{pq}} \right) \frac{v_p^2}{c^2} \right\}^{\frac{1}{2}},$$

$$v^2 = \frac{dx^2}{dt^2} + \frac{dy^2}{dt^2} + \frac{dz^2}{dt^2},$$

from which by further approximation in which the square root is expanded, keeping only the most important terms, we obtain for the Action the expression

$$A = \int \sum dt_p \left(\frac{1}{2} m_p v_p^2 + m_p \sum \frac{km_q}{r_{pq}} + \dots \right) + \text{constant}.$$

Now compare this with the ordinary dynamical Action from which by itself alone the entire system of equations of motion of any planetary astronomical system is derivable, namely,

$$A' = \int (T - W) dt = \int \sum dt \left(\frac{1}{2} m_p v_p^2 + \frac{1}{2} m_p V_p \right), \quad V_p = \sum \frac{\gamma m_q}{r_{pq}},$$

where V_p is the gravitational potential of the other masses at m_p . The former expression involves a plurality of independent co-ordinates t_p as free variables, one belonging to each body on its historic track: the latter has the one time-variable t . The former variables must somehow be reduced to a single one, in order to be expressive of the progress of history from stage to stage.⁹ In default of anything better, we previously, following the usual tacitly adopted course, simply substituted the same dt for each of these independent differentials dt_p ; as the result we had

$$A = \sum dt \left(\frac{1}{2} m_p v_p^2 + \frac{1}{2} \gamma m_p V_p \right).$$

On that pure assumption it proves to be possible to establish the necessary agreement between A and A' , merely by equating k to γ : whereas the geodesic postulate that each orbit is determined by itself alone from its own equation $\delta ds_p = 0$, with the same identification of dt_p with dt , would obviously, with Einstein, make k equal to 2γ .

Thus by use of the single invariant mutual Action, instead of the plurality of geodesic forms

⁹ It is just the negation of this consideration that has led to deposing time into an accident of place and motion, and so to abolishing history.

which as we hold are only spuriously invariant, both optical effects of gravitation were, on adopting perforce the usual procedure, reduced to half their observed values.

The weak link in the argument was recognised at the time, and has been already here sharply indicated. As nothing better suggested itself, the usual course was followed by replacing the independent co-ordinates t_p, t_q, \dots expressive in part of the positions of the bodies on their tracks in the fourfold, by one universal time-variable t . In another aspect, instead of conducting a general variation of position in the fourfold, it was restricted to displacements confined to hypersurfaces transverse to t ; which is not an invariant or intrinsic process, because t may belong to any slicing whatever of the fourfold.

NEWTONIAN TIME NOW INTRODUCED.

We now claim to be in a position to do better, as the Newtonian absolute time T has been acquired. The t_p is the variable of the type of time that is appropriate to the material system m_p , referred to the convenient frame of our problem in which all the local systems are taken as moving, this one with velocity v_p . It can be placed in relation to T , which is the time-variable appropriate to its own frame, changing relative to the others, in which m_p is always at rest, by a Lorentz transformation expressed at each stage, if x_p is taken for brevity along v_p , by equations of type ("Ether and Matter" (1900), p. 174: Lorentz, *Proc. Amsterdam Acad.* (1904): Einstein, *Ann. der Physik* (1905))

$$\delta X = \epsilon^{\frac{1}{2}} (\delta x - v \delta t), \quad \epsilon = \left(1 - \frac{v^2}{c^2} \right)^{-\frac{1}{2}}$$

$$\delta T = \epsilon^{\frac{1}{2}} \left(\delta t - \frac{v}{c^2} \delta x \right).$$

Here, now introducing subscripts, $\delta X_p, \delta T$ belong to the particular planet's own frame, $\delta x_p, \delta t_p$ belong for each planet to the solar frame to which the motions of all the planets have to be referred in a theory which includes them all. It is the transfer from δt_p to the universal δT , which is none other than the (reversed) familiar very slight relativity shrinkage of time, of order 10^{-8} , that rises to be an essential feature for orbits because δt always occurs with a factor c . The transfer is effected by the relation $\delta t_p = \epsilon_p^{-\frac{1}{2}} \delta T$; provided we can ignore the addition $-v_p/c^2 \cdot \delta x_p$ to δt_p in the formula, which expresses a change of epoch of T with locality analogous in Lorentz's striking comparison to change in civil terrestrial time for different longitudes. If our local standard frame of inertia, that is, such that dynamics of its material content is practically uniform and Newtonian, is not of too great extent, this omission makes no practical difference: the theory has however to remain approximate, though abundantly covering actuality, in this as in other respects, leaving the practical issues for systems involving speeds of a higher order than planetary still a riddle.

We can now introduce into the Action this unique absolute time T as subsisting intrinsically within every moving system m_p . But it may still be objected that t , as usually introduced in place of

t_p, t_q could be regarded as the absolute time on the sun, to which the motions of all the planets are thereby referred. This remark may suggest a contradiction in our processes: but it is removed by reflecting that though T is measured in the same unit on the sun and on a planet, being absolute, yet it is measured from different epochs, which we cannot specify, and which do not keep constant for the succession of elements of T because the planet's own frame of T is continually changing relative to that of the sun. The only δT that is a continuous differential of a function T , for the environment of the planet in which the process of variation is carried through, is by Newtonian postulation that one which constantly belongs to it, with its optically vibrating atoms, when referred to a frame continuously carried along as part of itself. It is this T that is the unambiguous cumulating time of the records of the astronomers, who work each in his own essential local landscape in which, as in all others, it inheres.

Reverting after these explanations to our analysis, by a simple substitution for dt^2 within the radical, we now have immediately, using isotropic forms for ds^2 , with sufficient approximation¹⁰

$$A = \int -c^2 m_p \left\{ \left(1 - \frac{km_q}{c^2 r_n} \sqrt{1 - \frac{v_p^2}{c^2}} \right) dT^2 \left(1 + \frac{km_q}{c^2 r_q} \frac{d\sigma_p^2}{d\sigma_q^2} \right) \right\}^{\frac{1}{2}}$$

$$= \int -c^2 m_p dT \left(1 - \frac{km_q}{c^2 r_q} - \frac{2}{c^2} \right)$$

$$\text{as } dt_p = \left(1 - \frac{v_p^2}{c^2} \right)^{\frac{1}{2}} dT, \quad d\sigma_p^2 = dx_p^2 + dy_p^2 + dz_p^2 = v_p^2 dT^2,$$

the product terms of higher order under the radical in A now, be it noted, cancelling out. Comparison with the Newtonian Action now restores k to the value 2γ as with Einstein; but the result may still differ (see, however, footnote *infra*) by second order terms from the Newtonian Action in a way which might affect sensibly the secular advances of the perihelia of the planets.

We claim in fact to have discovered how to transfer, with sufficient approximation, the reduced form of Action, constructed in the conglomerated fourfold in order to secure the requisite invariance, into the solar frame in space and time of the planets, which is competent to contain it and will lead to the development of dynamical astronomy by further variation in the usual manner with respect to the planetary positions.

Introduction of the factor transforming from the co-ordinate dt_p to a universal time dT has thus affected the kinetic energy of each body as it occurs in the reduced integrand of the Action with a factor 2, together with minor changes: and to restore large-scale agreement with the astronomical Action A' the potential energy has to be affected with the same factor, which requires us to make k equal to 2γ instead of γ . This new inconvenient common factor 2 would then be absorbed by amending the original Action form to $A = \int -\frac{1}{2} c m_p ds_p$, a change that will presently prove to be essential as regards the relation of mass to energy.

¹⁰ If a track p is regarded as made up of filaments which influence one another the summation $\sum km_q/c^2 r_{pq}$ ought to be increased by a constant k_p which is a sort of gravitational self-induction like that of an electric current on itself. This would function as a field-addition to mass, did it not cancel out as occurring in two places with opposite signs: there is no field-inertia of gravitation.

But a point arises here that demands close scrutiny, as it may be a main source of obscurity. Reduced to standard local form the transferable invariant ds is expressed by $ds^2 = c^2 dt^2 - d\sigma^2$; as ds is thus cdt for a frame in which the $d\sigma^2$ of a track locally vanishes, it has been customary in the theory to call $c^{-1}ds$ standard time. If this is meant to be the same dT as the present interval of absolute time, it involves the relation

$$dT = c^{-1}ds = \left(1 - \frac{v^2}{c^2} \right)^{\frac{1}{2}} dt = \epsilon^{-\frac{1}{2}} dt,$$

whereas our present result, derived from an immediate comparison of frames, is the direct opposite one, $dt = \epsilon^{-\frac{1}{2}} dT$. The justification for it is, briefly, that the Minkowskian fourfold determined by invariance of ds is not a frame of reference for matter in motion; its element of extension is rather a complex of local frames with all speeds of convection. Neither matter nor motion is discernible within the fourfold: it is on the present view a necessary consolidation of the relations of the permitted (locally inertial) frames, in any one of which the actual world can be framed as bodies in motion. But it bears traces of this composite origin, from groups of local frames with all possible motions of convection, in the historic tracks which are indirectly symbolic of the movement of bodies as exhibited in any of the merged constituent frames.

The $c^{-1}ds$, though it has been called standard time, has nothing to do with any moving material system: it is to the local material system itself in its own frame, as the essential *datum*, not to any or all of the other extraneous permitted frames of reference in their various convections relative to it, that the absolute time belongs. Though perhaps a relation between the epochs of T in two local systems is determinable ideally by counting the alternations in t along the undulatory ray connecting them, yet as time progresses the ray rapidly changes owing to their motions and no practicable relation could ensue. Or, expressed differently, the frame of the planet is constantly changing relative to the solar frame, which prevents a steady difference of time-epochs between their frames.

When we come, however, to determine the deflection of a ray passing near the sun it is the spatial gravitational field adjacent to the sun with which we are concerned. Referring the rays to the frame of the sun, the electrodynamic theory shows that the coefficient of dt^2 in the expression for ds^2 expresses with adequate approximation the square of velocity of light near the sun, while the curvature of the ray is by Huygens' principle the local gradient of velocity along its normal.¹¹ Thus the Einstein deduction for the deviation of the ray holds good with his coefficient 2γ as now restored, but on a different foundation, in place of γ .

RELATION OF ELECTRIC MASS TO ENERGY DEMANDS NEWTONIAN TIME.

The point has not yet been considered that the time-like co-ordinate t in the fourfold is not unique; for it is one of the impressive features in general relativity-theory that any mode of slicing of the

¹¹ This needs closer elucidation, now postponed.

hypercosmic fourfold may equally well express it. But what we are concerned with in our actual approximations is the simplified case which Levi-Civita has called Einsteinian statics, in which ds^2 involves no products of dt with other differentials: the ambitions of the wider abstract theory are scarcely practicable, and may be excessive. The motions of all local systems which have speeds small compared with light are then represented by historic tracks, now in a real (x, y, z, ct) fourfold, which are almost parallel: and the co-ordinates t_p, t_q, \dots of the various systems are suitably measured along some direction for t nearly parallel to them all. It is this simplification which makes an approximate development of the fourfold scheme practicable for actual astronomy, while leaving its relations to actuality unsolved for higher speeds.

It will be noted that in circumstances where the gravitational potential is negligible, the direct inertial part of the Action, as now expressed by

$$A = \dots + \int -\frac{1}{2} m_p ds_p,$$

where $ds_p = cd t_p \left(1 - \frac{v_p^2}{c^2}\right)^{\frac{1}{2}}$, $dt_p = \left(1 - \frac{v_p^2}{c^2}\right)^{\frac{1}{2}} dT$,

becomes $A = \dots + \int -\frac{1}{2} c^2 m_p \left(1 - \frac{v_p^2}{c^2}\right)^{\frac{1}{2}} dt_p$
 $= \dots + \int \{ \text{const.} + \frac{1}{2} m_p v_p^2 \} dT,$

when each system is referred to its own intrinsic absolute time; thus indicating that essential mass of an atom, as distinct from inertia derived from an attached field to some degree separable, is an intrinsic constant m_p , unaffected by its relation to frames of reference, as naturally it ought to be.¹² It would only be electric field-mass that is affected by its velocity in the frame, being related to field-energy relative to the frame.

Moreover the latter relation, fundamental though it be, is *not* substantiated at all except on the present Newtonian scheme. For an electric system it is common ground that the relevant reduced Action, of fourfold invariant type, must be of form, again with the new adjusting factor $\frac{1}{2}$,

$$\frac{1}{2} \sum e_p (F_p dx_p + G_p dy_p + H_p dz_p - c^2 V_p dt_p),$$

where $F_p = \sum e_q \hat{r}_{pq} / r_{pq}$, $V_p = \sum e_q / r_{pq}$.

For a static electric system it is thus, closely,

$$-\frac{1}{2} \sum c^2 e_p V_p dt_p, \text{ becoming } -\int W dt,$$

where W is its electrostatic energy, when all its electrons are travelling together so that t_p is the same for all. On introducing Newtonian time, but not otherwise, this is

$$-\int W \left(1 - \frac{v^2}{c^2}\right)^{\frac{1}{2}} dT,$$

which is the familiar form of Action indicative of varying inertia according to a law which makes the energy $W(1 - v^2/c^2)^{-\frac{1}{2}}$, thus showing its dependence on the translatory motion. For example, to our second order of approximation this Action is

$$\int \left(-W + \frac{1}{2} \frac{W}{c^2} v^2 + \dots \right) dT,$$

indicating an increase of inertia of amount W/c^2 .

¹² In a field of large uniform gravitational potential V_p an increase of inertia of m_p depending on V_p/c^2 is simulated: but that point of view is confused. The Action is the sole arbiter, which here determines the total result of the field as orbital motions.

CONCLUSION.

The conservation of Newtonian absolute time for local material systems, as supplied by their intrinsic vibrating atoms of matter, within the Einstein mathematical method of fitting the existence of gravitation into the optical relativity, has thus led to his value of the displacement of spectral lines, also as we have seen to his value for the ray-deflection, but not to his result for the precessions of planetary perihelia.¹³

It is noticeable how little use of the mathematical tensor theory is required for the general argument on the scope of relativity: it here provides only the form of ds^2 for the gravitational field within the solar system, as affected by each mass that is present, and that form is required only to a rough approximation, in order to identify a representation of gravitation within the formulation by ds^2 of the invariant fourfold, though closer calculation is necessary in order to determine the deflection of actual rays and the precessions of planetary perihelia.

Finally it will be observed that the present scheme has to be throughout an approximate one, leading as is claimed in a natural manner to the two optical effects of gravitation as now widely accepted. It works with frames of ordinary space and time, correlated in an auxiliary mathematical fourfold. It may be regarded as the continuation of the previous approximate scheme of electric equivalence of frames, of long ago, "Æther and Matter" (1900), Chapters vi, xi, which at that date covered adequately all the verified facts of optical and electrodynamic relativity, and justified the postulate of its universal validity at any rate up to the second order: without noticing, however, as Lorentz afterwards discovered by an equivalent independent electrodynamic formulation, that the formulæ on which it was based are obviously valid without approximation for the Maxwellian field; though valid only problematically, if at all, within the domains of the atoms, except to the second order of approximation there regarded as imposed on that account. The hypothesis of unrestricted exactness, regardless of structure in the atoms, has eventuated in wide and profound formulations towards hypercosmic schemes, which constitute the modern mathematical theory of relativity. The physical interpretations here advanced rest of course on the most brilliant Einsteinian fourfold device for involving gravitation within optical local relativity; that seems to have now become justified,—but as here urged when it is reconstructed into more consistent and Newtonian setting—by the astronomical tests, as the right type of mathematical formulation; in contrast with modes, one for example making use of a scalar gravitational potential in the fourfold, that might otherwise be in competition with it.

¹³ When the approximation to the reduced Action for the Sun-Mercury system is carried to the second order, it appears that its form comes out of the type of the Newtonian Action for an elliptic orbit. If this is confirmed, then on the present theory there would be no influence on the secular progress of the perihelion: which, amid the astronomical complications, and in face of the smallness of the outstanding residue, can scarcely now be regarded as an unsatisfactory conclusion. The masses have to be predominantly intrinsic, as in the text.

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Tyndall's Experiments on Magne-crystallic Action.¹

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

IN 1845, Faraday made the surprising discovery that the vast majority of substances, not merely iron, nickel, and cobalt, are affected by a magnet: and showed also that the action is repulsive quite as often as attractive. Faraday's results excited the gréatest interest and were the starting-point for many other researches. In fact, they paved the way for the work of Thomson and Maxwell, who came thereby to the establishment of the laws of electromagnetism. Among the many workers who followed Faraday was Tyndall, who made certain interesting discoveries relating to the behaviour of crystals in the magnetic field.

A very lively discussion sprang up as to the mode of interpretation of the new discoveries, particularly that of the so-called diamagnetism. On one hand, Faraday was satisfied that he could describe them in terms of his 'lines of force': the majority, including Tyndall, referred everything to the existence of poles, magnetic and diamagnetic. Tyndall's experimental work, and the consequences which he drew from it, were devoted to the support of these views. When Faraday's conceptions prevailed it became clear that Tyndall's interpretation of his own experiments must have been incorrect. His collected account of his researches, published in the well-known "Diamagnetism and Magne-crystallic Action," never became a link in the chain of argument.

The recent analysis of crystal structure by means of X-rays throws some new light on those experiments of seventy years ago. We can see more clearly where Tyndall's conclusions were in error. But at the same time the experiments of Tyndall are seen to be closely related to a modern research of immense importance, that of the effect of stress on the constitution and physical properties of materials.

FARADAY'S FIRST OBSERVATION OF DIAMAGNETISM.

On Sept. 13, 1845, Faraday made one of his most important discoveries, that of a relation between magnetism and light. He found that when plane polarised light was made to traverse a piece of his 'heavy glass,' a borosilicate of lead, in a direction coinciding with that of lines of magnetic force, the plane of polarisation was rotated. He had thus

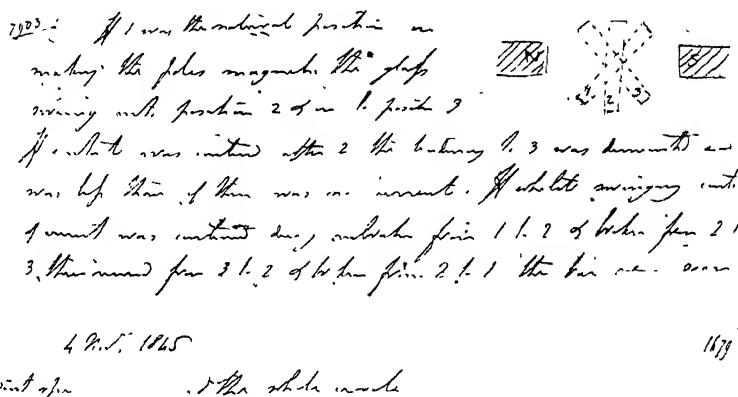


FIG. 1.—The above figure and a few lines of explanation are photographed from Faraday's original notes.

been successful in showing that the action of a magnet did not require the co-operation of a magnetic substance such as iron for its manifestation, but might be directly connected with a substance of a different kind, namely, glass, and a different activity, namely, light. In the following months he tried to find some other connexion between magnetism and this glass. He floated his glass on a liquid and tried whether he could move it by a magnet, without result. But on Nov. 4 he succeeded in his search.

"The bar of heavy glass, 1 $\frac{1}{2}$ of an inch long and . . . $\frac{1}{2}$ of an inch square, was suspended by cocoon silk in a glass jar in principle as before and placed between the poles of the last magnet. When it was arranged and had come to rest I found I *could* affect it by the magnetic forces and give it position. Thus touching diamagnetics by magnetic curves

¹ Discourse delivered at the Royal Institution on Friday, Jan. 21.

² Not filled in, but from other notes we know it was half an inch square.

and observing a property quite independent of light by which we may probably trace these forces into opaque and other bodies as the metals, etc."

"If 1 was the natural position on making the poles magnetic the glass swung into position 2 and on to position 3. If contact was united after 2 the tendency to 3 was diminished, *i.e.* was less than if there was no current. If whilst swinging contact of current was continued during vibration from 1 to 2 and broken from 2 to 3, then united from 3 to 2 and broken from 2 to 1 the bar was soon sent spinning round the whole circuit" (see Fig. 1).

The word 'diamagnetic' is here used to denote substances through which, on his views, magnetic lines were passing. It is not yet used as an anti-

pole, not *along* the lines as a piece of iron would do; and obviously the effect is very small as compared with the violent movements of iron in the same circumstances.

The action may be described as a repulsion of the glass by the magnet: and sometimes the early workers on the subject constructed apparatus specially designed to show the repulsive effect more obviously, and to distinguish it from a mere turning action in a magnetic field, if indeed this could be done. We can illustrate this point, and at the same time the diamagnetism of bismuth, by using a piece of apparatus constructed for Tyndall (Fig. 2).

FARADAY'S FIRST EXPLANATION OF DIAMAGNETISM.

Faraday at first suggested that the diamagnetic effect was the antithesis of the ordinary magnetic effect. A piece of iron when placed between two poles became so magnetised that a south pole was developed upon it in that part which was nearest to the north pole of the inducing magnet and vice versa. Faraday's suggestion that the diamagnetic substance developed north and south poles where a magnetic substance would have developed south and north respectively was taken to be a satisfactory explanation. It was the constant endeavour of later experimenters to express their results in accordance with Faraday's hypothesis: even when development had reached a stage some distance ahead of that described in the original paper (*Phil. Trans.*, 1846, p. 21).

Faraday was himself the first to feel doubts as to the satisfactory nature of his explanation. His early results could conveniently be described as showing an

exact antithesis between two classes; where one was attracted by a magnet, the other was repelled: where one set itself in a certain direction in the magnetic field, the other avoided that direction as much as possible. It seemed proper to describe them as being in exact antithesis to each other, and the word diamagnetism was adopted as a means of expressing the experimental result.

He prepared a list of substances which showed varying degrees of response to the action of the magnetic field, and the plan of the statement illustrates his first views ("Experimental Researches," Series xxi. No. 2424):—

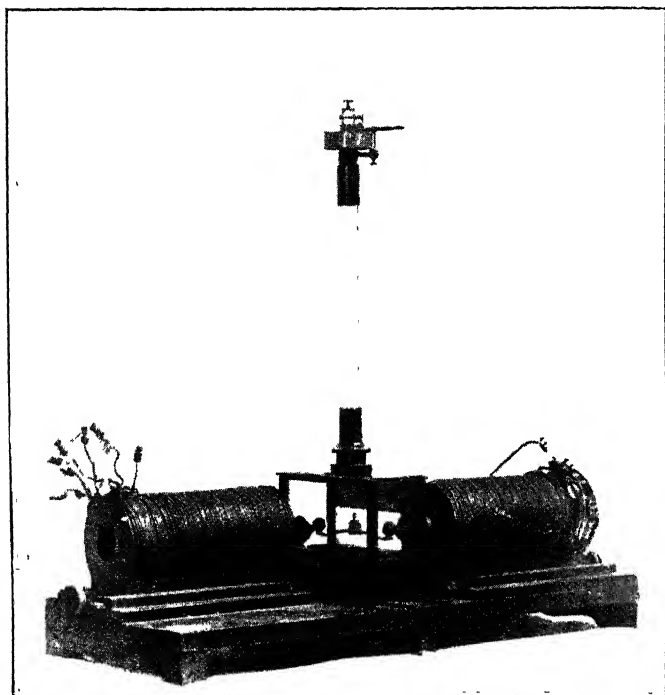


FIG. 2.—Apparatus used by Tyndall. Two balls of bismuth are placed at opposite ends of an arm swinging at the end of a suspension thread. The electromagnets are staggered so as to combine their actions in turning the arms by means of the repulsive forces exerted on the balls. ("Diamagnetism and Magneto-crystalline Action," p. 53.)

thesis to 'paramagnetic.' His new result obviously gave him intense pleasure, and in following it up he was so preoccupied that he did not even go to the meeting of the Royal Society on Nov. 20 when his paper on the "Action of Magnets on Light" was read.

We can easily repeat the experiment, using a piece of the same glass taken from the store left by Faraday. It is not the actual piece, Number 174, as he tells us in his notes, for this cannot be found. The glass turns slowly in the magnetic field, and its motions are obviously controlled by switching the current off and on. The glass tends to set itself *across* the lines of force running from pole to

Iron	Alcohol
Nickel	Gold
Cobalt	Water
Manganese	Mercury
Palladium	Flint glass
Crown-glass	Tin
Platinum	Heavy glass
Osmium	Antimony
0° Air and vacuum	Phosphorus
Arsenic	Bismuth "
Æther	

It is to be observed that those preceding air and vacuum are to be considered above zero or magnetic, those succeeding, below zero or diamagnetic, which is meant to imply a true antithesis.

In Dec. 1845 ("Experimental Researches," Series xxi. No. 2429), Faraday writes :

"Theoretically, an explanation of the movements of the diamagnetic bodies, and all the dynamic phenomena consequent upon the actions of magnets on them, might be offered in the supposition that magnetic induction caused in them a contrary state to that which it produced in magnetic matter ; *i.e.* that if a particle of each kind of matter were placed in the magnetic field both would become magnetic, and each would have its axis parallel to the resultant of magnetic force passing through it ; but the particle of magnetic matter would have its north and south poles opposite, or facing towards the contrary poles of the inducing magnet, whereas with the diamagnetic particles the reverse would be the case ; and hence would result approximation in the one substance, recession in the other."

Even at that time, however, Faraday's views were not firmly established : and we may repeat an experiment of his which shows the nature of the contrary influences that were impressing him. A small glass tube filled with a weak solution of the magnetic substance iron sulphate sets itself axially between the magnetic poles ; but if it is surrounded as it swings by a strong solution of the same substance, it sets equatorially. The tube appears to be magnetic as compared to air, but diamagnetic as compared to the strong solution.

Might not, on this analogy, all substances, and also air and vacuum, be magnetic, reacting to the magnet in the same way but to different degrees ? And might not bismuth exhibit its peculiarities, not because it is in antithesis to iron, but merely because it is less magnetic than the air ? Yet he writes as follows :

"Such a view also would make mere space magnetic, and precisely to the same degree as air and gases. Now though it may very well be, that space, air and gases, have the same general relation to magnetic force, it seems to me a great additional assumption to suppose that they are all absolutely magnetic, and in the midst of a series of bodies,

rather than to suppose that they are in a normal or zero state. For the present, therefore, I incline to the former view, and consequently to the opinion that diamagnetics have a specific action antithetically distinct from ordinary magnetic action, and have thus presented us with a magnetic property new to our knowledge" ("Experimental Researches," Series xxi. No. 2440, Dec. 1845).

The extract describes his first-formed opinion.

PLÜCKER'S DISCOVERY OF MAGNE-CRYSTALLIC ACTION.

The next important step is due to Plücker :

"In 1847, Plücker had a magnet constructed of the same size and power as that described by Faraday, his object being to investigate the influence of the fibrous constitution of plants upon their magnetic deportment ; while conducting these experiments he was induced to try whether crystalline structure exercised an influence" (Tyndall, "Diamagnetism and Magne-crystalline Action," p. 2).

The first experiment made by Plücker gave an immediate and decided reply. The investigation of the behaviour of several crystals led him to announce the following laws :

"When any crystal whatever with an optic axis is brought between the poles of a magnet, the axis is repelled by each of the poles ; and if the crystal possesses two axes, each of these is repelled with the same force by the two poles.

"The force which causes this repulsion is independent of the magnetism or diamagnetism of the mass of the crystal ; it decreases with the distance more slowly than the magnetic influence exerted by the poles."

There is some truth in Plücker's conclusions, but much correction is necessary. Tyndall pointed out in 1850 that they broke down completely when applied to calcium and iron carbonate. These two crystals are isomorphous ; the former, Iceland spar, obeys Plücker's laws in that it sets its axis equatorially in the magnetic field, but iron carbonate sets its axis from pole to pole. Plücker had, however, done great service in directing attention to the peculiar behaviour of crystals in the magnetic field.

In the autumn of 1848 Plücker was in London. Faraday writes in his laboratory notes :

"16 Aug. 1848. Plücker has described to me certain of his results as to the crystalline diamagnetic relation and, as I understand it, the optic axis of a crystal having *one* optic axis tends to pass into the equatorial direction, or if a crystal have two optic axes then the line between them tends to pass into the equatorial direction."

"25 Aug. 1848. To-day Plücker showed me for the first time some of his experiments.

"FIRST OPTICAL RESULTS.

"A small rhomboid of Cal^e Spar was suspended by a single cocoon thread between my Elect. Magnet poles with the optic axis in a horizontal position. When the poles were very close as in the figure the diamagnetic force of the substance made it take the position shown in which the optic axis is axial to the magnet. But when the poles were opened out to distance of half or threequarters of an inch, then the mass pointed axially and the optic axis therefore equatorially [see Fig. 3]. . . . There is a given distance between the Mag poles (pretty close) when a certain or piece

rhomboid Δ of Cal^e spar between them is so affected that the diamagnetic and the magneto-optic force is balanced, at smaller distances the piece points diamagnetic and at larger distances Magneto optic. So that on increasing the distance the magneto-

25 Aug 1848.

5 T. Day. (Handwritten) . . . of the first time of his experiments.

First optical results:-

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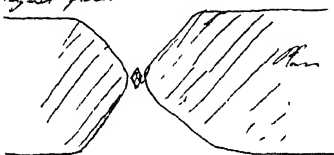


FIG. 3.—The figure is taken from Faraday's notes, Aug. 25, 1848.

optic force diminishes *less rapidly* than the magnetic force, and on diminishing the distance it increases less rapidly than the magnetic force. *But increasing or diminishing the strength of the magnet produces no alteration of this place of neutral action, it only increases or diminishes the strength of the action on each side of it: or rather the resultant of the two actions on each side of that neutral position.* So Plücker at least tells me, for I did not see that proved."

Plücker's experiment is readily shown; but a little care in adjustment is required. The dimensions of an equal-sided rhomb are rather too much the same in all directions: a somewhat more irregular piece is, I find, easier to work with. The effect is much more clearly seen with a good bismuth crystal, which was obtained in the following way. A little bismuth was melted in a glass tube which had been drawn to a point. The tube was placed in an electric furnace, from which it was made by clockwork to emerge very slowly. The fine end of the tube came out first, and the bismuth at the point was the first to solidify into crystalline form.

The rest of the metal crystallised slowly as the emergence proceeded, and, in the circumstances, continued the structure and orientation of the first fragment. In this way, due to Bridgeman, the mass contained large single crystals, not a mass of fine crystals as is usual when the solidification takes place rapidly.

When the crystal, which is ten times as long as it is broad, is placed in the magnetic field due to pointed poles, it sets strongly equatorially in accordance with the usual behaviour of a diamagnetic body: but when the poles are withdrawn somewhat, it sets axially with equal strength.

The experiments of Plücker introduced a new effect which Faraday afterwards called "magne-crystallic action." It clearly deserved a name, since its manifestations added a complication to the diamagnetism which had already been observed.

The new discoveries presented so many forms when repeated with different crystals suspended in different ways and with different forms of magnetic field that the complications were not unravelled for some years. Some of the difficulties were due to the circumstances of the experiments and had no relation to the real question. One of these incidental effects was that of attractions and repulsions due to transient currents induced in bodies already suspended for observation between the magnetic poles when the

magnets were excited. As is well known, the motion of a spinning block of copper is at once arrested by the action of such currents; on the other hand, a sheet of copper held near a pole is sharply repelled when the current is turned off, and if properly suspended can be set into a rapid spinning. These effects had nothing to do with diamagnetism, but they were apparently the cause of confusion on some occasions.

Another great source of difficulty was the overpowering effect of iron impurities; the diamagnetic effects are so feeble in all cases that a mere trace of iron, nickel, or cobalt is sufficient to mask them. So, for example, Plücker's experiments with antimony seem on this account to have been at variance with the true facts as proved by Faraday (Tyndall, p. 16).

FARADAY'S RESEARCHES ON MAGNE-CRYSTALLIC ACTION.

In 1848, Faraday published a series of researches on the magne-crystallic phenomena, which cleared

up some of the difficulties. But in 1850 he could still write as follows :

" Four years ago I suggested that all the phenomena presented by diamagnetic bodies, when subjected to the forces in the magnetic field, might be accounted for by assuming that they then possessed a polarity, the same in kind as, but the reverse in direction of, that acquired by iron, nickel, and ordinary magnetic bodies under the same circumstances. This view was received so favourably by Plücker, Reich, and others, and above all by W. Weber, that I had great hopes it would be confirmed ; and though certain experiments of my own did not increase that hope, still my desire and expectation were in that direction. (2641) Whether bismuth, copper, phosphorus, etc., when in the magnetic field are polar or not is, however, an exceedingly important question ; and very essential and great differences in the mode of action of these bodies under the one view or the other, must be conceived to exist. I found that in every endeavour to proceed by induction of experiment from that which is known in this department of science to the unknown, so much uncertainty, hesitation, and discomfort arose from the unsettled state of my mind on this point that I determined if possible to arrive at some experimental proof either one way or the other. This was the more important because of the conclusion in the affirmative which Weber had come to in his very philosophical paper. . . . (2642) It appeared to me that many of the results which had been supposed to indicate a polar condition were only consequences of the law that diamagnetic bodies tend to go from stronger to weaker places of action ; others, again, appeared to have their origin in induced currents. . . ."

Accordingly, he undertook a further series of researches which in the end brought him to regard all his effects as expressible in the simple form with which we are familiar. In his " Experimental Researches " he writes (Ser. xxvi., Oct. 1850, No. 2807) :

" When a paramagnetic conductor, as for instance a sphere of oxygen, is introduced into such a

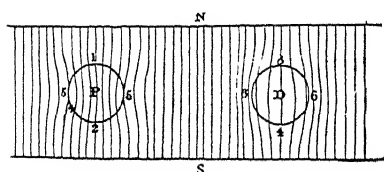


FIG. 4.—The figure is taken from Faraday's " Experimental Researches," and was drawn to show his conception of the passage of lines of magnetic force through paramagnetic and diamagnetic bodies respectively.

more magnetic power than before. If, on the other hand, a sphere of diamagnetic matter be placed in a similar field it will cause a divergence or opening out of the lines in the equatorial direction, and less magnetic power will be transmitted through the space it occupies than if it were away" (see Fig. 4).

This describes diamagnetism generally : the complication of magne-crystallic action is described with equal simplicity :

" (2837) If the idea of conduction be applied to these magne-crystallic bodies it would seem to satisfy all that requires explanation in their special results. A magne-crystallic substance would then be one which in the crystallised state could conduct onwards, or permit the exertion of the magnetic force with more facility in one direction than another : and that direction would be the magne-crystallic axis. Hence, when in the magnetic field, the magne-crystallic axis would be urged into a position coincident with the magnetic axis by a force correspondent to that difference, just as if two bodies were taken, when the one with the greater conducting power displaces that which is weaker."

It is only a uniaxial crystal, of course, which possesses a single magne-crystallic axis ; it is the axis of a certain spheroid. The facility of conduction in different directions in a biaxial crystal requires an ellipsoid for its representation.

This way of stating the rules allows us to see at once the principle of the experiments shown by Plücker to Faraday, which the latter so greatly extended. When the magnet poles were close, the crystal occupied a part of the field where the lines of force were very divergent. In such circumstances the orientation of the crystal would be determined by the general tendency for diamagnetic bodies to move from the stronger to the weaker parts of the field, and the crystal set its longer dimension perpendicular to the field ; the optic axis was then parallel to the lines of force. But when the magnetic poles were separated the crystal covered a part of the field in which there was little divergence : the magne-crystallic action then took charge, and the crystal set itself so that the direction of worst conduction of the lines, *i.e.* the optic axis, was at right angles to the lines.

EXPERIMENTAL ILLUSTRATION OF MAGNE-CRYSTALLIC ACTION.

A few simple experiments will serve as further illustration of these rules. We take a crystal of sulphate of iron which has the form of a thin plate : the flat sides are cleavage planes and the ' conducting power ' for Faraday's lines is far greater across the plate than along the large faces. In a uniform field the crystal plate sets equatorially therefore, and even when allowed to move up to one of the poles keeps its face normal to the lines. A thin plate of iron would stand on edge on the pole : but the magne-crystallic action of this paramagnetic crystal is exceedingly strong.

A bismuth crystal so suspended that its axis (it is a uniaxial crystal) is vertical has no magne-crystalline action. Its motions are governed by the general tendency of its mass to move from the stronger to the weaker parts of the field: in a uniform field it has no appreciable tendency to set itself in any particular direction. But when the crystal is hung so that the axis is horizontal, that axis tends strongly to set itself along the lines of force, as we saw before.

Naphthalene is a monoclinic crystal. Its magne-crystalline properties are represented by an ellipsoid, one axis of which coincides with the single axis of symmetry. The cleavage

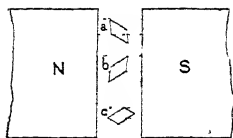


FIG. 5.—In this figure the positions marked *a* and *b* are positions of equilibrium of the naphthalene crystal in the magnetic field. The axis of symmetry is vertical and perpendicular to the plane of the paper. The cleavage plane is also vertical and its intersection with the plane of the paper is the longer side of the rhomboid. The form of the crystal shown in the figure is not a natural form, because the shorter side of the rhomboid is drawn parallel to one face of the cell of the crystal lattice, which face does not usually occur on the crystal. It is so drawn in order to show the relation between magnetic lines and the lattice.

If the crystal is hung from one end of the *b* axis, the position *a* is assumed, and if from the other, the position *b*. The position *c* is impossible.

soid then lies along the lines, another across them: the third is vertical. There is no obvious relation between the cleavage plane and the first two axes. Finke (*Annalen der Physik*, 31, 149; 1910) has shown that this may be said of various crystals examined by him. If now the crystal be suspended from the other end of the axis, its cleavage planes will make the same angle with the field but on the opposite side of the medial line (Fig. 5). Faraday describes results of this kind which he obtained with a paramagnetic crystal of sulphate of iron ("Experimental Researches," Series xxi. Nos. 2634-7). Naphthalene is diamagnetic: like many other organic crystals, it shows the magne-crystalline effect very strongly.

These experiments will serve to show the great variety of effects that may be observed. All of them are, however, easily correlated by Faraday's conception of lines of force. Let us remember that

there are several variables and give due importance to each. The first of these we call diamagnetism, implying that the lines pass through the substance in question less easily than through the air or a vacuum. The second is called magne-crystalline action, in reference to the fact that in a crystal the lines pass more easily in one direction than another. A third variable is the crystal shape, which may also affect the set in the magnetic field when the latter is divergent. A fourth is the amount of divergence of the field which, in a uniform field, falls to zero. After experimental disturbances have been allowed for, all these influences have to be taken into account.

The more divergent the field the more does the simple diamagnetic effect assert itself, and any magne-crystalline action which would tend to make the specimen set a crystal axis or axes at some particular inclination to the direction of the field is overpowered.

THE CONTRAST BETWEEN PARAMAGNETISM AND DIAMAGNETISM.

On the other hand, magne-crystalline action usually takes charge in a truly uniform field. For the sake of brevity and an easier explanation, it may be well to direct attention to a fact which was not fully appreciated by all the first experimenters, but was clearly set out by Sir William Thomson (Lord Kelvin) in 1885. A diamagnetic bar, apart from magne-crystalline action, tends to set itself *along* the lines of force in a *uniform* field, just as a paramagnetic bar. For we may imagine the bar to be made up gradually of a collection of cubes, placed successively one after the other in the magnetic field. The effect of the first cube is, as we should say in the language of Faraday, to spread out the lines of force on their way through the cube, and to crowd them together on either side

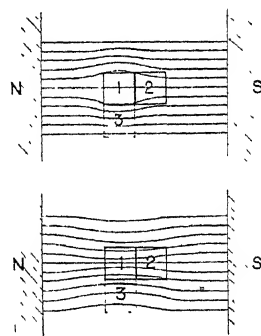


FIG. 6.—Dia- and paramagnetic substances in a magnetic field. In both cases Position 2 is preferred to Position 3.

of it. A second diamagnetic cube will, if free to move, go to that part of the field where the lines are least crowded; it will therefore avoid setting itself beside the first cube and prefer to place itself in front or behind it. A third will continue the same process, and in the end the cubes will form a bar pointing along the lines. In the case of a substance such as iron, there is a double converse.

The lines are most dense just in front and just behind the first cube ; and a second cube will place itself in one of those positions because a magnetic substance seeks the strongest part of the field. Again, therefore, the bar grows along the lines, as in this case we know from experience (see Fig. 6).

It is quite certain that no one has ever seen the first of these effects, because it must be so minute and difficult to separate from others. We may safely infer it, as Thomson pointed out, because our theories of the electromagnetic field have been abundantly justified by other means. The susceptibility of bismuth, by far the most diamagnetic substance, is only about 10^{-6} ; in other words, the strength of the field on one side of a bismuth cube of 1 cm. side would only be about a thousandth part of 1 per cent. greater than at the front or back of the cube. Near a pointed pole the strength of the field might easily vary by 50 per cent. in a centimetre. It is easy to see how feeble is the force tending to arrange the supposed cubes parallel to the lines of a uniform field as compared with the forces acting on a bar placed near the pole.

The analogous effect in electrostatics can, however, be realised. When two plates are immersed in oil and maintained at a large difference of potential, an elongated rod of glass hung from a fibre sets itself along the lines of force (to make sure that the effect is true the rod must be free from any conductivity due to its own substance or a water film). This corresponds to the setting of a magnetic body in a uniform field. When bubbles of air are allowed to rise through the oil they are³ drawn out along the lines of force ; which effect, since the inductivity of air is less than that of oil, represents the setting of a diamagnetic body along lines of magnetic force.

When a diamagnetic substance sets itself across the lines of a magnetic field, and no magne-crystalline action is at work, it is because the field is not really uniform. It is perhaps a little confusing when it is said, as is sometimes the case, that diamagnetic and paramagnetic substances are the antitheses of one another in that one kind sets itself across the field and the other along it. This is only true of a field which is non-uniform. Indeed, it may be said that the use of the word antithesis is incorrect in any case. There would be a true antithesis if one substance could be defined by its pointing along the lines of force in one direction while another pointed in exactly the opposite direction ; there is no true antithesis between pointing along the lines and pointing across them. It seems to

me, though I say it with diffidence, that this difficulty was stirring in Faraday's mind and was the true cause of the uneasiness of which he spoke in a quotation given above, and of his aversion to the description of diamagnetism and paramagnetism as being the antitheses of one another.

Faraday, as I have said, when this thorough examination of the facts had led him to frame a hypothesis which would link them together, based his interpretation on the existence of lines of force, and found himself able to place both his own results and those of others in their place within a self-contained system.

Kelvin placed this hypothesis in mathematical form, thus completing the treatment of the subject of magnetism by Poisson ; the latter had left out of his consideration the consequence of magnetic susceptibility being different in different directions, not because he overlooked the possibility of such an effect, but because no case of its occurrence was known to him.

THE HYPOTHESIS OF POLARITY.

Faraday's views were not accepted, however, by other experimenters on the same subject, and in particular by Tyndall. The idea of polarity was not to be given up easily, and innumerable experiments were made to show that a 'diamagnet' had poles like a magnet, but in the opposite sense. A bar of bismuth would develop north and south poles when, in similar circumstances, a bar of iron would develop south and north. Of course, when the facts are prepared for mathematical treatment, they can be expressed in this way. It is generally convenient and justifiable to represent a magnet by two poles because the form of the field at any reasonable distance is satisfactorily represented thereby, though in the immediate neighbourhood the lines of a real magnet do not run like those of the theoretical bipole. Within the body of the magnet the lines run from the south pole to the north, continuing and completing their course outside so that every line is a closed circuit ; but all lines near a bipole run from the north pole to the south pole. So also in the magnetic shell, which is in the mathematical treatment the exact analogue of the electrical condenser, the bulk of the lines run from one plate to the other across the narrow space between the two plates ; comparatively few run from the outside of one plate, through surrounding space, to the back of the other. In the condenser, the internal field is the most important, the external being looked on as a correction. In the magnetic shell the reverse is the case ; the outside

³ My authority is Capt. Dunsheath of the Henley Telegraph Works Co.

field is that which is considered because it represents more and more closely, as the plates are brought closer together, the field due to a current circulating about the contour of the condenser. The theoretical charges on the plates have to be made larger and larger as the plates are brought together, so that the strength of the outside field may remain the same.

Now, if a piece of bismuth is placed along the lines of a magnetic field, the lines avoid the piece to some extent, though, as already explained, the avoidance is extremely small. If we take the bismuth away and replace it by a feeble bipole

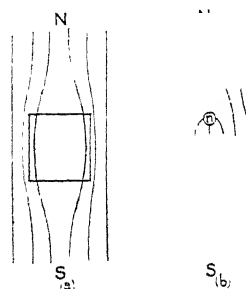


FIG.

consisting of south-pole magnetism, of proper amount, where the lines come out of the bismuth, and a corresponding amount of north-pole magnetism where they go in, the whole arrangement being made in a vacuum, or permissibly, in the air, we get (Fig. 7) in this artificial way an

external field resembling that which exists when the bismuth is in place. It can be said that polarity is developed in the bismuth in a sense opposite to that which is found in iron in the same circumstances. If the effect is to be represented, for the convenience of treatment, as due to the presence of a bipole, then the sense of the bipole in the case of bismuth is opposite to the sense in the case of iron. The old argument, therefore, was not between two hypotheses but between two languages in terms of which the facts were to be described. Such an antagonism, once believed in and debated, could be and was the cause of an immense variety of experiments devised to justify one side or the other. But Faraday felt that his way of putting the facts was more fruitful in suggestion of further experiments, and more convenient as a foundation for theoretical development. He has been abundantly justified.

THE WORK OF TYNDALL AND KNOBLAUCH.

We now come to the part which Tyndall played in a debate which was conducted on both sides in such an able and, it is pleasant to observe, in such a friendly way. In the first place, Tyndall and Knoblauch published in 1850 an account of experiments which they had made. They showed that Plücker's first views, those which included the repulsion of the optic axis of a uniaxial crystal by the poles of the magnet, were, as already stated,

incorrect in many cases, and they substituted an amended set of rules in the following terms:

"If the arrangement of the component molecules of any crystal be such as to present different degrees of proximity in different directions, then the line of closest proximity, other circumstances being equal, will be that chosen by the respective forces for the exhibition of their energy. If the mass be magnetic this line will set axial; if diamagnetic, equatorial."

The key-word is "proximity." This condensed statement of course requires explanation. Tyndall supplies it in full in his book on "Diamagnetism and Magne-crystalline Action." A very brief summary will be sufficient for our present purpose. In the first place, the observations made by him and his partner on the behaviour of crystals in the magnetic field convinced them that the plane of cleavage determined in a number of cases the position which the suspended crystal would take. Magnesium sulphate, zinc sulphate, saltpetre, and topaz were diamagnetic substances, and their cleavage planes, the crystals being so suspended that these planes were vertical, always set themselves equatorially, *i.e.* at right angles to the field. On the other hand, nickel sulphate, scapolite, and beryl, which were magnetic crystals, in the same circumstances set their cleavage planes parallel to the field.

The connexion between these results and the statement quoted above lies in this, that the molecules in a crystal were supposed to be in greater proximity along a cleavage plane than in any other direction. Let us take bismuth as an example; it is diamagnetic and sets its cleavage plane equatorially in accordance with Tyndall's rule. Its structure has now been determined by X-ray analysis, so that we can see what meaning can be attached to the claim for proximity in the plane of cleavage. The bismuth structure can be looked on, approximately, as a slightly distorted cube; one of the cube's diagonals has been a little stretched, while the other three have been left unchanged. The crystal is therefore uniaxial; the axis is the stretched diagonal. The principal cleavage plane is perpendicular to the axis. The spacing of the planes parallel to the cleavage is larger than that of any other set of planes in the crystal, and these consequently contain more molecules to the unit area than any other planes. Tyndall would have said that in those planes there was a maximum proximity between the molecules.

The X-ray analysis of other crystals often shows the cleavage plane to have the largest spacing and

therefore the closest degree of packing. This means that the points of the crystal lattice are closest together in that plane, but it does not mean that the atoms or molecules are nearer together in that plane than in any other. Nothing can be said about that until the actual distribution of the atoms in the unit cell has been determined. It would be much safer to say that the existence of a cleavage plane implies a certain *looseness of packing across* the crystal planes which are parallel to the cleavage. This would imply a greater tightness in other directions, but not necessarily a greater proximity. It is only at first glance that the latter term seems to have a clear meaning. But we must let it stand in order to realise the argument as it presented itself to the authors of the statement quoted.

It happens that in the case of bismuth we do actually find a closer bonding between the atoms in the cleavage plane than in any other; but this is peculiar to the structure of bismuth and has no relation to the supposed close proximity of *molecules* in the cleavage plane.

Now we come to the essential point of the argument. It is supposed that proximity offers magnetism or diamagnetism, whichever it may be, the opportunity to "exhibit its greatest energy." We are to remember that the hypothesis on which we are working expresses itself in terms of poles and that a magnet attracts a piece of iron by inducing poles in it, which poles then react with the poles of the magnet. When a piece of iron is allowed to attach itself to a magnet, the poles induced in it are much stronger than if the magnet and the iron are separated by a little distance. If a second piece of

iron is brought near the first, every increase in its proximity increases the strength of the poles which are developed in this piece by the influence both of the original magnet and of the first piece of iron.

A simple experiment will serve as an illustration (Fig. 8): The nail hangs in the first case, and not in the

although the magnet is actually closer to it. The benefit of mutual 'proximity' of the separate pieces of iron is obvious. An equally simple explanation can be given in terms of lines of force, but we are using the alternative language.

Chains of iron fragments form readily between magnet poles of opposite nature. A rod of iron "transmits the magnetic force," and generally acts more efficiently than a set of iron fragments which are not allowed to get into close proximity with each other. Tyndall sticks short lengths of iron wire through disc-shaped pieces of apple and shows that the disc sets itself at right angles to the field, the bits of wire therefore lying parallel thereto. In each bit are many molecules of iron in close proximity, and the fact is more effective in directing the apple than the existence of a number of bits scattered over the disc without being in 'proximity' to each other.

DIAMAGNETISM AND 'PROXIMITY.'

It is now argued by Tyndall that if the magnetic influence of a magnet is extended by means of proximity, the diamagnetic influence must be extended in the same way. If the close proximity of iron fragments will help them to set with greater firmness in the direction joining opposite poles, then the closer proximity of bismuth fragments should cause them to set with greater firmness across them. In this way Tyndall interpreted the rule, which he believed he had established, that the cleavage planes of magnetic crystals tended to set axially, and those of diamagnetic crystals equatorially.

It is interesting to observe that Tyndall was attempting to supply both a rule for the setting of crystals and an explanation of the rule in terms of structure. Faraday stopped short when he had supplied a picture of the distribution of his magnetic lines, or, as we should now say, a map of the distribution of energy in the magnetic field.

As I have already pointed out, there is no clear meaning to the term "greater proximity in the cleavage plane." Moreover, if conclusions were to be drawn from analogy with phenomena on a larger scale, they would run contrary to the intended argument; for, on that scale at least, a line of diamagnetic masses tends to set itself axially, not equatorially. A piece of bismuth makes an extremely minute alteration in the disposition of the lines of force, for which reason it is a very poor detector of the existence of the lines in comparison with iron; and the change, since it is so small, can indeed be detected by a piece of iron in the form of a magnet, but certainly not by

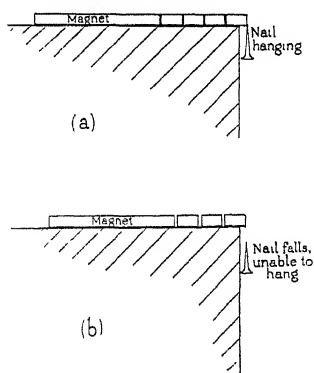


FIG. 8.—When pieces of iron are all in contact with one another and the end one with the magnet, the nail can hang as shown in (a). But when, as in (b), the iron blocks are somewhat separated from one another and from the magnet, the nail falls.

second, because the close proximity of the iron blocks increases the strength of the poles in all of them. In the second case, the nail will not hang,

another piece of bismuth, no matter how close they are together.

In the case of a uniaxial crystal, a principal cleavage must from symmetry considerations be related to the axis and, if it is unique, must be perpendicular thereto. When there is more than one cleavage, the cleavage planes must be symmetrically disposed about the axis as in the case of Iceland spar. It is not, therefore, surprising that, in the former case, the cleavage plane should place itself exactly, either equatorially or axially, and that in the latter case a plane perpendicular to the axis might be looked on as a resultant of cleavage planes and therefore set itself equatorially. But it does seem remarkable that, as Tyndall pointed out, the substitution of iron for calcium in Iceland spar, to form the isomorphous iron carbonate, should turn the structure round through 90° in the magnetic field; especially if we assign diamagnetism and paramagnetism to different causes. It may be there are other cases of the same change; and any rule of this kind must clearly be of importance.

THE EFFECTS OF PRESSURE ON MAGNETIC SUSCEPTIBILITY.

We now come to another set of experiments, very interesting and important, which were used by Tyndall in the defence of the 'polarity' position. The method of these experiments was suggested by an accident. When working in Berlin with a fine magnet placed at his disposal by Magnus, he was observing the action of the magnet on a bismuth cube which was so shaped that two opposite faces were perpendicular to the optic axis and parallel to cleavage planes. When the current was switched on, the magnet poles rushed together because the separate parts of the magnet had not been properly bolted down. The bismuth cube was crushed to some extent. Working conditions having been restored, it was found that the bismuth set itself at right angles to its former position. The line of pressure, which, of course, had been parallel to the field, was now perpendicular to it. Tyndall now argued that the particles of bismuth had been brought into greater proximity by the pressure and that the setting of this line of great proximity was in accordance with the rule given by himself and Knoblauch. So began an extended series of researches on the effects of pressure which are fully described in his book. As an example let us take the following:

"A quantity of bismuth was ground to dust in an agate mortar, gum-water was added, and the

mass was kneaded to a stiff paste. This was placed between two glasses and pressed together; from the mass when dried two cubes were taken, the line of compression being perpendicular to two of the faces of each cube and parallel to the other four. Suspended by a silk fibre in the magnetic field, upon closing the circuit the line of compression turned strongly into the equatorial position. . . ."

When carbonate of iron was used the line of pressure set axially.

Such an experiment is very striking, whatever its explanation may be. Tyndall argued that he had by compression increased the proximity along the line of pressure, but it is difficult to see how this can be. If a number of particles of one kind are distributed with complete irregularity in a paste medium which is then subjected to pressure in one direction, the alteration in form of the paste block will not alter the law of distribution of the particles. In any case, as we have already seen, proximity does not produce any observable effects.

LORD KELVIN'S EXPLANATION OF TYNDALL'S RESULTS.

It is surely natural to suggest that the particles acquired some orientation from the pressure, which might well happen if they possessed shapes which were related in some particular way to their structures. Thomson immediately pointed this out to Tyndall, who replied that if that were the case, the bismuth fragments being naturally in the form of flakes parallel to the cleavage plane, the line of pressure ought therefore to set itself axially, whereas it actually set equatorially. This was certainly a good reply. Perhaps the counter argument is that the crystal fragments have not actually been shown to set in this way. Miss Knaggs has made an X-ray measurement of the set of the fragments in one specimen of squeezed dough containing bismuth particles, and has found that the cleavage planes are not closely coplanar with the surface, as they must be if Tyndall's argument is to be good. Though this is a single example, it looks as if a way of escaping the difficulty was to be found.

As I have said, Tyndall's reply to Thomson was good, but, to use his own words, though it formed "a strong presumptive argument it was not yet convincing." He strengthened his case greatly by a further experiment. Comparing the repulsion exerted by a magnet on a natural crystal of bismuth with that exerted on a mass of compressed powder in dough, he found the latter greater than the former. He had cut the crystal into the form of a cube and placed it on one arm of a torsion balance

so that the cleavage plane was perpendicular to the magnetic field, and the repulsive force as great as it could possibly be. The dough had been pressed into a cube of the same size and placed with its line of pressure at right angles to the field. Tyndall argued that there must be a direct effect of pressure, since it had done more than all that the natural phenomena could do.

Now it is clear that if the orientation of a bismuth crystal in a uniform magnetic field, *i.e.* the magne-crystallic action, is due to the arrangement of the atoms and molecules in the crystal structure, the perfect crystal ought to show the effect more perfectly than the fragments distributed through the dough, however perfectly the latter may be arranged. But Miss Knaggs has made an X-ray photograph from the face of a natural 'crystal.' The specimen was chipped out of a mass of crystals left in a crucible, and must have resembled that which Tyndall used. The photograph showed at once that the specimen was a compound of more than one crystal, and that different orientations were present. Cleavage planes, and also others which in a single crystal would make large angles with the cleavage planes, were nearly parallel to the face under test. It is possible, therefore, that there was really more of the effective orientation in the pressed specimen than in the natural piece. A photograph of the single crystal made by Bridgman's method taken in the region of the cleavage plane gave a much cleaner picture.

A piece of bismuth can be looked on as an aggregate of crystals. There may be but one perfect crystal or there may be a number, small or large, of smaller crystals, each perfect. If proximity were increased by pressure, the change in proximity would have to occur in respect to the mutual distances in either of the separate crystals, or of the atoms and molecules in the single crystal. The X-ray analysis shows that the latter alternative is impossible, because from many tests recently carried out in respect to metal structure, we learn that no permanent change in the crystalline lattice is occasioned by stress. The former alternative is also ruled out, because, as Faraday pointed out,⁴ bismuth is actually of a lower density after compression than it was before; the pressure having of course been removed. Apparently the breaking up of the specimen increases the extent of the cavities.

Tyndall made many paste models of crystals, mixing powders of bismuth, carbonate of iron, or

other active substances with flour and water, or gum. He pressed the mass by different amounts in different directions and then cut it to shape: in this way he imitated the magne-crystallic action in detail. At one time, in order to meet the objection that he was merely rearranging the small crystals in his paste and conglomerates, he took some white wax "concerning whose amorphism there can be but little doubt." The substance is diamagnetic. A little cylinder of the wax suspended in the magnetic field set with its axis equatorial. It was then placed between two stout pieces of glass and squeezed as thin as a sixpence; suspended from its edge, the plate thus formed set so that its length, which coincided with the axis of the previous cylinder, was axial and its shortest dimension equatorial. But we know now that wax is anything but amorphous; its crystalline structure has not only been observed but also accurately measured; and we know also that pressure arranges the orientation of the crystals.

Tyndall obtained the same result with a piece of bread, and we may repeat the experiment. A small piece of the crumb is squeezed between two glass plates, and the edges of the irregular mass are trimmed off, so as to leave a thin disc. When this is suspended so that its plane is vertical, it sets equatorially if the poles are close together and the field is very divergent. It is therefore diamagnetic. But when the bread is moved from the space between



Fig. 9—The black lines show different positions of a thin wafer of pressed bread hung by a single fibre. In the outer parts of the magnetic field it sets more or less along the lines, but as it is brought up to the more intense parts, where there is great divergence of the lines, it turns so as to set itself at right angles to the field.

the poles to a more uniform part of the field, the plane of the disc turns through a right angle and sets itself parallel to the lines of force. It is quaint to observe how the bread, as it is moved up to the poles, sets itself to pass neatly through the narrow gate and take up a parallel position on the further side. This is due to magne-crystallic action, so that the bread contains crystals, a fact easily verified by X-ray methods.

THE EFFECTS OF PRESSURE ON CRYSTALLINE CONDITION.

The long series of interesting and ingenious experiments which Tyndall made to show that pressure produced proximity and proximity produced the equivalent of magne-crystallic action, must be held to have failed in their original purpose. But they will doubtless be put to a different use.

⁴ His reference was to "Gmelin's Handbook of Inorganic Chemistry," vol. 4, p. 428.

They are related to a subject of immense importance in these days, namely, the effects of pressure and tension and mechanical treatment generally, upon the state of a material and upon its physical properties. The consideration of such questions is fundamental to metallurgy and to other industries. The microscope has for many years been employed for the purpose, and the new methods of X-ray analysis are already being put into service. It may well repay us to consider Tyndall's experiments in a new light; and to examine the actual nature of those rearrangements which produced such remarkable changes in magnetic reactions. Tyndall himself discussed the effects of pressure in producing planes of possible cleavage, and was one of the pioneers in showing how such planes, occurring in the earth's crust, were not always to be interpreted as the result of sedimentary deposition, but rather of pressure, which might, if it were exerted more or less along the deposition planes, produce cleavages across the latter. He extended the principle to account for stratification in rolled materials, even in biscuits and pastry!

Faraday's use of lines of force did not, in reality, demand so much framing of hypothesis as Tyndall's polarity. It is to be observed that, as Faraday pointed out, they had no differences about facts, merely about methods of description, which methods, however, were of different value as suggesting development. To Faraday's conceptions have been added theories of magnetism and diamagnetism based on the existence of resistanceless molecular circuits as imagined by Ampère and Weber, or on revolving electrons as explained by Langevin. In the most recent times the quantum theories have again modified our ideas.

MODERN CONSIDERATIONS.

The crude hypothesis of the molecular circuit leads simply to a useful point of view of the difference between paramagnetism and diamagnetism, and the most modern discussions, though they differ greatly in appearance, leave that point of

view almost untouched. If any of Faraday's lines of force thread a circuit which has no electrical resistance, that number can never be changed. If, therefore, a substance be brought into a magnetic field, the molecular circuits in the atoms of the substance act like obstructions to the lines; and the total obstruction, of which the negative magnetic susceptibility is a measure, is proportional to the sum of the areas of all these circuits, as projected on a plane perpendicular to the lines. It is of no consequence whatever whether there are already currents in those circuits; unless, indeed, the circuits are movable and can alter their set towards the imposed field. Thus the diamagnetism is unaffected by the existence of molecular magnetic fields; or by any changes in them, so long as the total of the projected areas of the circuits is unchanged.

This result does not hold if circuits approach each other so closely that they offer less obstruction to the lines than if they were more separated. Two resistanceless circuits running closely parallel to each other offer little more opposition to the passage of lines than either circuit alone. We should imagine that such changes in the relative position of circuits would only occur in strenuous circumstances such as, possibly, those of crystallisation. It is known that diamagnetic susceptibility may vary very slightly: for example, Oxley has shown that crystallisation sometimes brings about small but definite alterations. As has often been pointed out, this simple theory makes diamagnetism a property of all substances, which can be affected, even overwhelmed, when the circuits already contain currents, and therefore can be orientated afresh by the magnetic field.

Let me say in conclusion that although recently acquired knowledge of the structure of materials leads us to reconsider Tyndall's experimental results, we are still far from the full explanation of the connexion between structure and magnetism, and of the influence of the latter upon physical properties.

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The Prediction of Eclipses.

By Dr. L. J. COMRIE.

THE fact that astronomers can predict, many years in advance, the time of a solar eclipse to within a few seconds, and the region on the earth's surface in which it will be visible to within a mile or so, will perhaps surprise the layman. Yet attention was directed to the forthcoming eclipse of June 29 more than half a century ago by the Rev. S. J. Johnson in his "Eclipses Past and Future."

These advance predictions are possible because eclipses pass through a definite cycle, or repeat themselves after an interval of 18 years $11\frac{1}{3}$ days. To explain the reason for this, consider the conditions that lead to an eclipse. It is well known that the earth moves round the sun in a nearly fixed plane called the ecliptic. As seen from the earth the apparent motion of the sun in the heavens is along the great circle which represents the intersection of the ecliptic plane and the celestial sphere, or the ecliptic circle. If the motion of the moon round the earth were in the same plane, then once in every lunar month of $29\frac{1}{2}$ days the moon would be in line with the sun, and an eclipse would result. Actually the plane of the moon's orbit is inclined to the plane of the ecliptic at an angle of 5° . This means that the great circle representing the moon's orbit crosses the ecliptic at two opposite points or nodes, while half-way between the nodes the nearest possible approach of the two bodies is 5° .

Should the sun happen to be within a certain limiting distance from either of these nodes at the time the moon crosses the ecliptic, there will be an eclipse, either partial or total. If the nodes remained fixed on the ecliptic, eclipses would take place at the same two seasons each year. Actually the nodes make a complete circuit of the ecliptic in a backward or retrograde direction in a little less than nineteen years, so that the sun, in its annual course through the ecliptic, returns to the same node, not in 365.24 days, but in 346.62 days, a period called the eclipse year. Nineteen of these periods equal 6585.78 days. The interval between successive conjunctions of the sun and moon, or,

in other words, the interval between successive new moons, is called the synodical month, and is 29.53 days. 223 of these lunations contain 6585.32 days. That is to say, if the sun and moon at any given moment are in conjunction at or near a node, so that an eclipse is in progress, then after 6585.32 days they will again be in conjunction and in the immediate neighbourhood of a node, so that another eclipse will occur.

The circumstances of an eclipse vary considerably with the distance of the moon from the earth—from an annular eclipse when the moon is at its maximum distance of about 257,000 miles to a long total eclipse of perhaps six or seven minutes' duration when the distance is as small as 223,000 miles. The interval between successive returns to the same distance from the earth, or the anomalistic month, is 27.55 days, and 239 of these intervals are 6585.54 days. Thus not only is there a repetition of the eclipse after 6585 days, but also it will occur under practically the same conditions.

This most useful period of recurrence was known to the Chaldeans as the Saros, and formed the basis of their very successful eclipse predictions. It is still used for the purpose of fixing the dates on which eclipses will occur, although the details of the eclipses are obtained by more refined methods.

One question must be answered. Why was not a total eclipse visible in England eighteen years ago, in 1909? The reason is that 223 lunations exceed 6585 days by about 8 hours, and in that time the earth has rotated, so that successive corresponding eclipses occur, on the average, 120° of longitude farther to the west.

Mention should be made here of Oppolzer's celebrated "Canon der Finsternisse" (Vienna, 1887), which gives particulars of all eclipses between 1207 B.C. and A.D. 2161, together with maps showing the central lines of total eclipses. An inspection of these maps indicates that the eclipse of 1999 will be total in Cornwall only, and that the next total eclipse visible in England in 2135 is the first of a group of four that will be seen in

the course of 25 years, namely, in 2135, 2142, 2151, and 2160.

The accurate prediction of a solar eclipse is dependent ultimately on accurate predictions of the positions of the sun and moon. These bodies have been carefully observed with meridian circles for more than two centuries. The principal object in founding the Royal Observatory at Greenwich was the making of these observations, and to this day unrelaxing efforts are made to observe every meridian passage. In the hands of those masters of celestial mechanics, Delaunay, Hansen, Leverrier, Newcomb, Hill, and Brown, these observations and Newton's gravitational theory have led to tables from which the positions of the sun and moon for any date in historical times, or for centuries to come, may be found. Even the eclipses recorded by the ancients have contributed to these tables, for it is evident that the tables should reproduce the eclipses as observed.

The tables used by the "Nautical Almanac" are Newcomb's "Tables of the Sun" and Brown's "Tables of the Moon." The latter is a ponderous tome, too heavy, when bound, to be accepted by the British Post Office! Its two million figures, printed at Cambridge for the Oxford University Press, are the life-work of an English-born professor living in the United States. It requires the continuous efforts of two highly skilled computers to produce from these tables the hourly ephemeris of the moon given annually in the "Nautical Almanac."

The problem of predicting the circumstances of an eclipse for a given point on a non-spherical rotating earth would at first sight seem hopelessly difficult. But the classical solution offered a century ago by Bessel, and later most ably expounded by Chauvenet, has, by the simplicity, beauty, and rigour of its conceptions, lived to this day.

The movements of the sun and moon are expressed by means of suitable rectangular co-ordinates on a fundamental plane through the centre of the earth, and at right angles to the line joining their centres. The shadow of the moon is a cone, the intersection of which with the fundamental plane is a circle. Upon this same plane the position of the observer is projected orthographically, and the projected distance from the origin, which is the centre of the earth, is resolved into components parallel to the previously chosen axes.

The co-ordinates x and y of the moon's centre, which are also the co-ordinates of the centre of

the shadow, and those of the observer ξ and η , will be the same on a plane through the observer and parallel to the fundamental plane, but the radius of the shadow-cone, L , which is readily determined, will be different. The fundamental equation of eclipse prediction simply expresses the condition that when an eclipse is beginning or ending the observer is on the edge of the shadow cone, or his distance from the centre of the shadow cone is equal to its radius. Symbolically,

$$(x - \xi)^2 + (y - \eta)^2 = L^2.$$

The two times when this quadratic equation is satisfied represent the beginning and ending of an eclipse.

The quantities x and y , the dimensions of the shadow cone, and other functions which are independent of the position of the observer, are tabulated in the "Nautical Almanac" for each eclipse as Besselian elements. With the aid of these elements, complete predictions for any given place can be made in a few hours.

The difficulties which prevent the making of perfect predictions must now be reviewed. First, the diameters of the sun and moon. When a bright body is projected on a dark background it appears to be larger than its true size—a phenomenon known as irradiation. Hence the diameter of the moon as usually measured has to be considerably reduced for eclipse purposes; in fact, the so-called eclipse diameter, which is used in predictions, has been determined from eclipse observations alone. Further, the limb of the moon is irregular, owing to the presence of lunar mountains; on this account alone an exact prediction cannot be made, for a valley 1000 feet deep could affect the time of eclipse by a second or more, especially if the observer were near the northern or southern limit of totality.

Another difficulty lies in the unavoidable errors of the solar and lunar tables. These arise partly from the fact that some of the quantities required in their construction, such as, for example, the masses of perturbing planets, are exceedingly difficult to determine, even from a prolonged series of observations. Another contributory cause is the fact that there appear to be some unknown influences at work. Prof. E. W. Brown, formerly a pupil of the illustrious George Darwin, in the preface to his "Tables of the Moon," says: "While many efforts have been made in the past to represent the motion of the moon by gravitational theory alone, it is now admitted that this cannot be done completely. . . . There are oscil-

lating differences which do not correspond to any theoretical gravitational terms. . . . The causes of these differences . . . are matters of conjecture.¹ . . . Still more puzzling are certain oscillations with smaller amplitudes and shorter periods. . . . All that can be done is to make an estimate . . . from the observations of the past few years whenever it is desirable to predict the position of the moon with high accuracy, as in the case of an eclipse of the sun, and alter the values obtained from the Tables accordingly."

When the coming eclipse was first accurately predicted three years ago, a correction of $+7''.0$ was applied to the mean longitude of the moon as derived from Brown's "Tables," but, strangely, no correction was applied to the position of the sun. The Astronomer Royal, Sir Frank Dyson, has quoted the corrections to the longitude of the sun and moon derived from recent Greenwich observations as $+1''.5$ and $+6''.5$ respectively. When these corrections replace those formerly used, the effect is very slight; it amounts to a displacement of the central line and the zone of

¹ Since the above was written, in 1918, several astronomers have suggested that the earth's period of revolution is variable, and have adduced evidence of a correlation between the anomalies in the motions of the Sun, Moon, Mercury, Venus, and Mars.

totality as shown on the Ordnance Survey Eclipse Map, the data for which were computed from the original elements, by just one mile in a north-westerly direction.

The residual uncertainty, after the application of these corrections, should be less than half a mile in the case of the central line, and not more than a mile in the case of the northern and southern limits of totality.

The co-ordinates of the central line, and the circumstances of the eclipse along this line, are given in the table below:

G.M.T.	Longitude.	Latitude.	Sun's Altitude.	Sun's Azimuth.	Duration.
5h 23m 0	$+4^{\circ} 55' 0$	$52^{\circ} 32' 1$	$9^{\circ} 8$	$64^{\circ} 2$	20.9
10	$4^{\circ} 35' 6$	$52^{\circ} 43' 3$	$10^{\circ} 1$	$64^{\circ} 5$	21.2
20	$4^{\circ} 16' 7$	$52^{\circ} 54' 3$	$10^{\circ} 3$	$64^{\circ} 8$	21.5
30	$3^{\circ} 58' 3$	$53^{\circ} 5' 0$	$10^{\circ} 6$	$65^{\circ} 1$	21.7
40	$3^{\circ} 40' 3$	$53^{\circ} 15' 5$	$10^{\circ} 9$	$65^{\circ} 4$	22.0
50	$3^{\circ} 22' 8$	$53^{\circ} 25' 8$	$11^{\circ} 1$	$65^{\circ} 7$	22.3
5 24 0	$+3^{\circ} 5' 7$	$53^{\circ} 35' 8$	$11^{\circ} 4$	$66^{\circ} 0$	22.6
10	$2^{\circ} 48' 9$	$53^{\circ} 45' 7$	$11^{\circ} 6$	$66^{\circ} 3$	22.9
20	$2^{\circ} 32' 5$	$53^{\circ} 55' 4$	$11^{\circ} 8$	$66^{\circ} 5$	23.2
30	$2^{\circ} 16' 4$	$54^{\circ} 4' 9$	$12^{\circ} 1$	$66^{\circ} 8$	23.5
40	$2^{\circ} 0' 6$	$54^{\circ} 14' 2$	$12^{\circ} 3$	$67^{\circ} 1$	23.7
50	$1^{\circ} 45' 1$	$54^{\circ} 23' 4$	$12^{\circ} 5$	$67^{\circ} 3$	23.9
5 25 0	$+1^{\circ} 29' 8$	$54^{\circ} 32' 5$	$12^{\circ} 7$	$67^{\circ} 6$	24.2
10	$1^{\circ} 14' 8$	$54^{\circ} 41' 5$	$12^{\circ} 9$	$67^{\circ} 8$	24.4
20	$1^{\circ} 0' 0$	$54^{\circ} 50' 3$	$13^{\circ} 2$	$68^{\circ} 1$	24.6
5 25 30	$+0^{\circ} 45' 5$	$54^{\circ} 59' 0$	$13^{\circ} 4$	$68^{\circ} 3$	24.9

The Recurrence of Solar Eclipses.

By Dr. J JACKSON.

AMONGST the most remarkable of discoveries made by ancient astronomers was that of the recurrence of eclipses at intervals of 18 years and 10 or 11 days. We have no knowledge of the discoverer of this period, known as the Saros, but it was certainly known to the Chaldeans. In view of the irregularities of the early calendar, such a discovery must have presented great difficulties. The fact that the interval has an odd third of a day, so that the region of visibility of an eclipse is shifted about 120° in longitude at each return, greatly increases the difficulties of discovery, and it is possible that a period three times as long as the Saros was first discovered. As the area of the earth from which an eclipse can be seen extends over a large arc in longitude, it is possible for two consecutive members of a series of eclipses to be seen from the same place. The total eclipse visible in England on Aug. 11, 1999, is indeed four Saroses later than that of June 29 of this year, but whereas this year's eclipse is in the early morning, the eclipse of Aug. 11, 1999, will be visible in England shortly before noon.

The circumstances connected with the recurrence of eclipses depend on several variables

with different periods, and the apparent irregularity with which eclipses occur results from the incommensurability of the periods and differences in their relative importance. The most important period is that between successive new moons, which on the average is 29.5306 days. An eclipse of the sun would take place at every new moon if the orbital planes of the sun and moon coincided,¹ but as the inclination of the two planes is considerable—varying round 5° —it is only when new moon occurs near the line of intersection of the two planes, known as the line of nodes, that an eclipse can take place. On account of the motion of the plane of the moon's motion, the sun passes through the nodes at intervals of less than six months, the average time being 173.310 days, and this is the second important period in connexion with eclipses. Eclipses take place at intervals which are very nearly multiples of 29.5306 days and are approximately multiples of 173.310 days.

The maximum angular distance which the sun

¹ If this were the case, however, all central eclipses would take place within the tropics, and the only eclipses that could be seen from England would be extremely small partial eclipses at the new moons near mid-summer.

can be from the node at the time of an eclipse (known as the eclipse limit) depends on the distances of the sun and moon from the earth and the actual inclination of the orbital planes. It varies from $15\frac{1}{2}^{\circ}$ to $18\frac{1}{2}^{\circ}$. As the sun moves on the average almost exactly $2 \times 15\frac{1}{2}^{\circ}$ relative to the nodes between successive new moons, and as it is moving most slowly when the eclipse limits are smallest, an eclipse occurs near every passage of the sun through a node. There are thus at least two solar eclipses every year, and there may be as many as five, the latter only occurring when

period of 1200 years. Of these, about twelve or thirteen at each end are only partial eclipses, as the sun is so far from the node that the line going through the centres of the sun and moon passes clear of the earth. For the middle, forty-five or so, this line comes to earth, giving rise to a central eclipse which is total or annular according as the angular diameter of the moon or sun is the larger.

The eccentricity of the apparent orbit of the sun is small, so that the angular semi-diameter of the sun varies only from $15' 46''$ to $16' 18''$. Also we have seen the Saros differs from an exact number

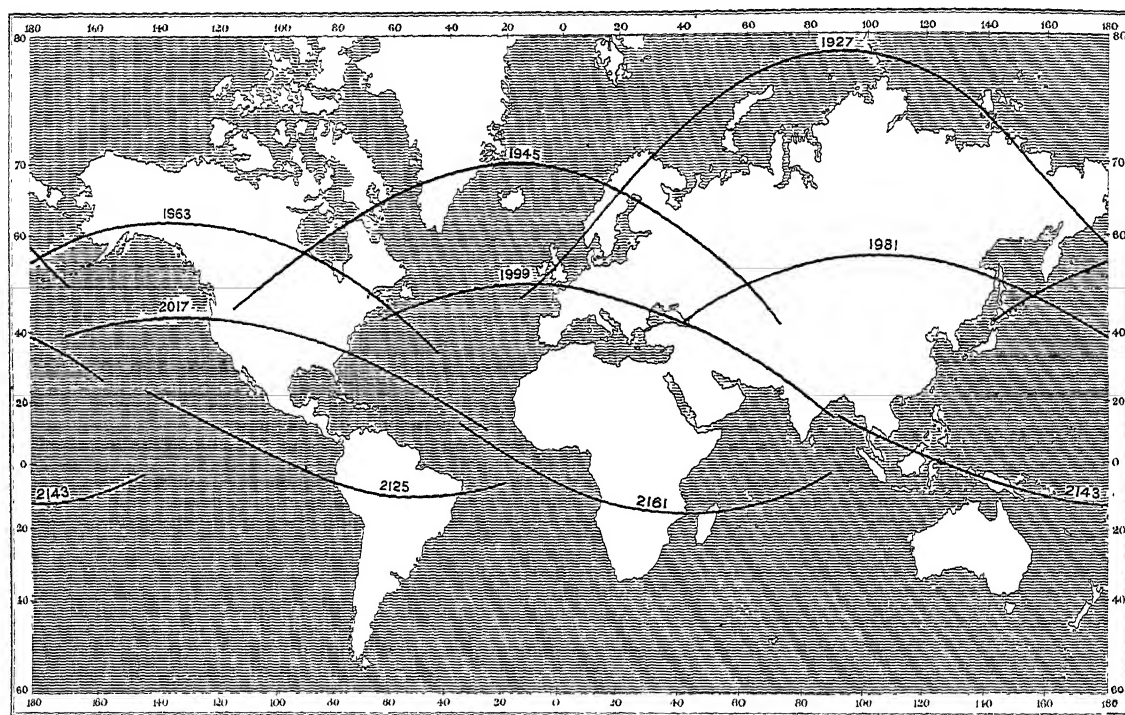


FIG. 1.—Successive tracks of solar eclipses.

the sun passes through a node near the beginning or end of the calendar year. Eclipses of the moon may take place at the full moons preceding and following eclipses of the sun, although for them the eclipse limits are smaller.

The Saros is connected with the two periods we have just mentioned. We have in fact

$$\begin{aligned} 223 \times 29.5306 \text{ days} &= 6585.32 \text{ days.} \\ 38 \times 173.310 \text{ ,,} &= 6585.78 \text{ ,,} \end{aligned}$$

The Saros is 6585.32 days. As the sun travels on the average about 1° a day, it describes in a Saros only about $28'$ less than 19 revolutions relative to the nodes. As $28'$ is a small fraction of the eclipse limits, we find a large number of eclipses recurring in a series.

The number of eclipses in a series varies one or two either way from seventy and extends over a

of years by about 11 days, so that at the recurrence of an eclipse the apparent diameter of the sun cannot have altered more than $3''$. The eccentricity of the lunar orbit is larger, causing the apparent semi-diameter of the moon to vary from $14' 42''$ to $16' 46''$. On account of the rather rapid motion of the moon's apse, amounting to a whole revolution in about nine years, the interval between successive nearest approaches of the moon to the earth is on the average 27.55455 days and

$$239 \times 27.55455 \text{ days} = 6585.54 \text{ days.}$$

This differs from the Saros by only 0.22 of a day. This is a remarkable and important coincidence. It means that after a Saros the mean anomaly of the moon has altered by only about $2^{\circ}.8$ (decrease), and the apparent diameter of the moon, like the sun, has not altered by more than $3''$. The con-

sequence of all this is that the duration of totality in a series of eclipses varies slowly from one eclipse to the next, and that we have a series of total eclipses, or of annular eclipses. If the period of rotation of the lunar apse were twelve years instead of nine years, annular and total eclipses would alternate. It might be noted here that as a result of the moon returning to approximately the same distance from the earth after a Saros, its parallax is only slightly altered, and so the eclipse limits only slightly altered.

Let us now consider the series of eclipses to which that of June 29 of this year belongs. At the new moon of May 26, 1873, the central line from the sun to the moon passed just north of the earth and there was a large partial eclipse near the north pole. If we work backwards from this date at intervals of 18 years and 10 or 11 days, we find a series of decreasing partial eclipses near the north pole. Going forwards, we find that on June 6, 1891, the central line passed over the north pole but came to earth in northern Asia, producing an eclipse at midnight. This was an annular eclipse very nearly total, and was the first central eclipse of the series to which the eclipse of this year belongs. Eighteen years later, on June 17, 1909, there was an eclipse which crossed the earth near the pole. This eclipse was just total, although it was scarcely certain beforehand that it would be so. We then come to the total eclipse of this year. Proceeding onwards, we get a series of eclipses gradually lengthening in duration and working equatorwards, while the longitude on the earth where the eclipse takes place moves about 120° westward from each eclipse to the next.

The "Nautical Almanac" gave the semi-diameters of the sun and moon as seen from the centre of

the earth for the eclipses of 1891, 1909, and 1927 as follows :

	Moon.	Sun.
1891 June 6 .	15' 42".2	15' 47".5
1909 June 17 .	43".1	44".3
1927 June 29 .	46".7	44".0

These figures indicate the way in which the apparent diameter of the moon is gradually increasing relative to that of the sun. Also on the eclipse track the apparent diameter of the moon must be larger than from the earth's centre, so that the total eclipses of this series will be steadily lengthening.

The following table indicates the change of position of the point on the earth where central eclipse occurs at noon, for a few eclipses belonging to the series of the eclipse of this year. The longitudes are measured towards the east. It will be seen that the track moves about 8° southward each year and a little more than 100° in longitude. After two hundred years, when the track is near the equator, the movement is about 5° southward and 120° westward each year.

	Longitude E.	Latitude.
1909 June 17 .	187°	+88°
1927 June 29 .	84	+78
1945 July 9 .	340	+70
1963 July 20 .	234	+62
1981 July 31 .	127	+54
1999 Aug. 11 .	18	+46
.....
2107 Oct. 16 .	39	+ 2
2125 Oct. 26 .	276	- 4
2145 Nov. 7 .	150	- 9
2161 Nov. 17 .	23	-14

The map (Fig. 1) shows the track of the approximate central line for the eclipses of 1927, 1945, 1963, 1981, 1999, 2017, and 2125, 2143, 2161. In each case the eclipse begins at the western end of its track at sunrise and finishes at the eastern end at sunset.

Future Total Solar Eclipses in the British Isles.

By Dr. A. C. D. CROMMELIN.

AN article by Dr. W. J. S. Lockyer in NATURE for Jan. 15 last described and illustrated the total solar eclipses in the British Isles from A.D. 878 to A.D. 1999. The present article continues this investigation for another thousand years. In view of the very long interval of two centuries that has elapsed since there has been a British totality, it is interesting to determine the average interval between these events. Mr. J. Maguire's list, used by Dr. Lockyer, has a few omissions. I therefore had recourse to the maps in Oppolzer's Canon of Eclipses. These indicate

63 British totalities in 3370 years (1208 B.C. to A.D. 2161), or 19 in a thousand years, giving an average interval of 54 years between totalities. I am aware that the maps in the Canon show the tracks as circular arcs not quite agreeing with the true ones, but for statistical purposes this is of no importance; we clearly gain as many as we lose by the distortion.

As a check I find that Otto Schrader gives 21 eclipses as total in the British Isles in the period A.D. 2133 to A.D. 3045. Four of these are doubtful; the central line lying outside these islands: giving

these half weight, we have 19 in 900 years, or 21 in a thousand years. So we are safe in concluding that the average number in a thousand years is 19 or 20, giving an average interval of 53 years. I have here included the Shetlands in the British Isles. If we exclude them (they were not included in Dr. Lockyer's map, reproduced in Fig. 1) we may take the average interval as about 58 years.

If instead of a large area we consider a point on the earth's surface, we have on the average 3 total

and spread out at another in a manner that recalls the service of tram-cars. The blank period of 203 years that is now ending is the longest between A.D. 800 and A.D. 3100. The gap between A.D. 2200 and A.D. 2381 comes second, and that between A.D. 1433 and A.D. 1598 third.

On the other hand, the most striking example of bunching is between A.D. 2081 and A.D. 2200; we have here seven certain totalities and two others that are likely to reach the shores of Great Britain within 119 years.

The following are the data from which the tracks in the accompanying map (Fig. 2) were laid down:

(1) For the period A.D. 2000 to A.D. 2161 they are from my own calculations, using the elements in Oppolzer's Canon.

(2) For A.D. 2189 from my own calculations, using Hansen's tables of the moon and Newcomb's of the sun. This eclipse was inadvertently omitted by Schrader.

(3) From A.D. 2200 to the end from Otto Schrader, "Die bedeutenden Sonnenfinsternisse und die grossen Mondfinsternisse für Mittel-Europa" (P. Stankiewicz, Berlin, 1913).

It is to be remembered that the lunar tables used by Oppolzer omit many small terms; consequently the eclipse tracks calculated from them are uncertain by about 25 miles at the present time; and since the accelerations used in them differ considerably from those now accepted, the uncertainty becomes markedly greater after an interval of

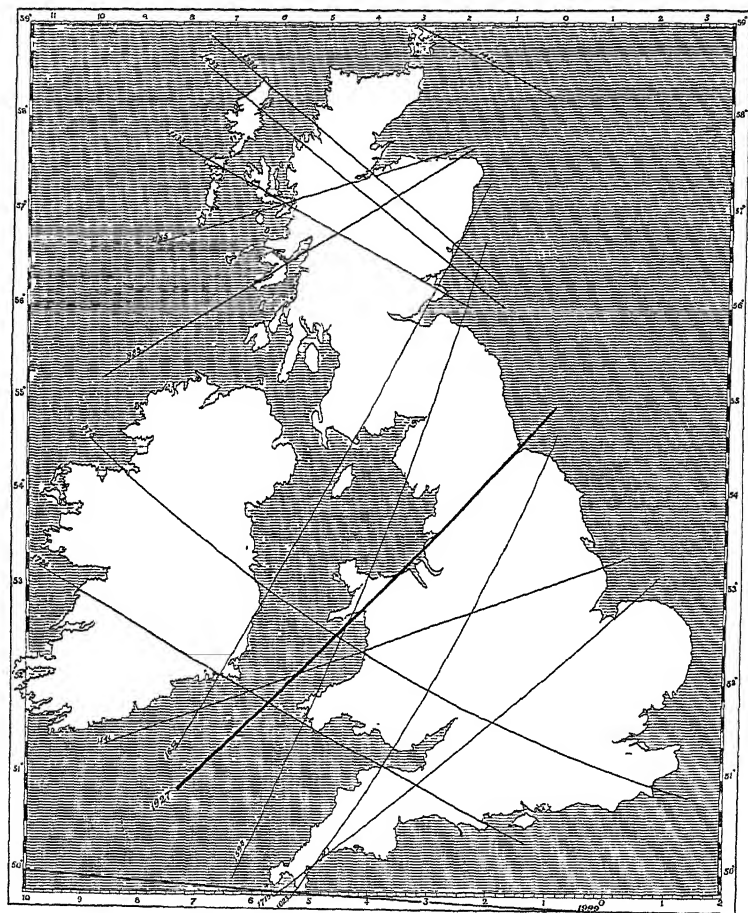


FIG. 1.

eclipses, 4 annular ones, and nearly 400 partial ones visible there in 1000 years. But we should have to take several thousands of years to make the average numbers for totality and annularity correct. In shorter periods we find some striking anomalies; thus a small region in Scotland round the point $3^{\circ} 40' \text{ W.}$, $55^{\circ} 30' \text{ N.}$; will have three totalities all under favourable conditions within 61 years (A.D. 2381, 2426, and 2442). Also, the grouping of totalities in the British Isles as a whole is much less regular than we might expect as a result of three such uniform motions as the rotation and revolution of the earth and the revolution of the moon. They bunch at one epoch

several centuries either in the past or the future. I understand that the tables used by Schrader are simply an extension of Oppolzer's, so they are subject to similar uncertainty, and tracks several centuries ahead can only be taken as approximate.

A few notes follow on some of the eclipses the central lines of which are shown on the map. The eclipse of A.D. 2081 is a return after seven Saroses of the Philippine Islands' eclipse of 1555, which has the remarkable duration of totality of $7^{\text{m}} 6^{\text{s}}$. If Oppolzer's data are accurate totality should reach the Lizard. Although the central line in A.D. 2090 is some distance from the shores of the British Isles, the track is so wide through foreshortening

that the shadow will reach the south-west coast. In A.D. 2142, totality may reach Dungeness. In A.D. 2151, Oppolzer's elements would give totality in London, but those of Hind, Maguire, and Johnson do not; their tracks are farther north. The eclipses of A.D. 2381, 2681, and 2726 are remarkable for long totalities. The latter seems to be a record for Europe, reaching 6 minutes. The Lizard will probably be within the shadow; the Channel Islands certainly will.

The following table gives the dates of all total eclipses that may reach the shores of the British Isles, the approximate hour, the sun's altitude and the duration on the central line. I have diminished the durations given by Oppolzer's and Schrader's elements by 0.2^m , since they use too large a diameter for the moon.

Date.	Hour.	Sun's alt.	Dur.
2081 Sept. 3	7 A.M.	18°	3.5 ^m
2090 Sept. 23	5 P.M.	6	2.8
2133 June 3	9 A.M.	40	3.5
2135 Oct. 7	8 A.M.	7	2.7
2142 May 25	9 A.M.	43	2.9
2151 June 14	6 P.M.	15	2.6
2160 June 4	6 P.M.	22	2.1
2189 Nov. 8	8 A.M.	8	2.5
2200 April 14	5 P.M.	17	0.4
2381 July 22	10 A.M.	48	5.0
2426 Sept. 2	8 A.M.	25	3.9
2442 April 11	9 A.M.	33	1.7
2545 April 12	5 P.M.	15	0.2
2600 May 5	6 A.M.	12	2.7
2681 June 8	2 P.M.	50	4.5
2726 July 21	11 A.M.	58	5.7
2808 Aug. 13	6 A.M.	8	0.3
2817 Sept. 2	4 P.M.	21	0.9
2864 Feb. 28	1 P.M.	29	2.8
2911 Aug. 15	2 P.M.	37	3.0
2927 Mar. 24	2 P.M.	31	3.0
2972 May 4	3 P.M.	37	3.8
2974 Sept. 7	1 P.M.	35	4.1

The central lines of 2081, 2090, 2726 pass respectively 70, 140, and 93 miles south of the Lizard; that of 2974 passes 44 miles north-east of Unst (Shetlands).

In the above list the eclipses of A.D. 2081, 2135, and 2189 illustrate the triple Saros; those of A.D. 2133, 2151, and 2142, 2160 the simple Saros; those of A.D. 2864, 2972 the sixfold Saros: the

intermediate eclipse in 2918 passes north of the Shetlands. Those of A.D. 2081, 2381, and 2681, also A.D. 2142, 2442, also A.D. 2426, 2726, illustrate the 300-year cycle: those of A.D. 2160, 2681 illustrate the 521-year cycle.

Taking the present list and Dr. Lockyer's together, there are two examples of a 2-year interval

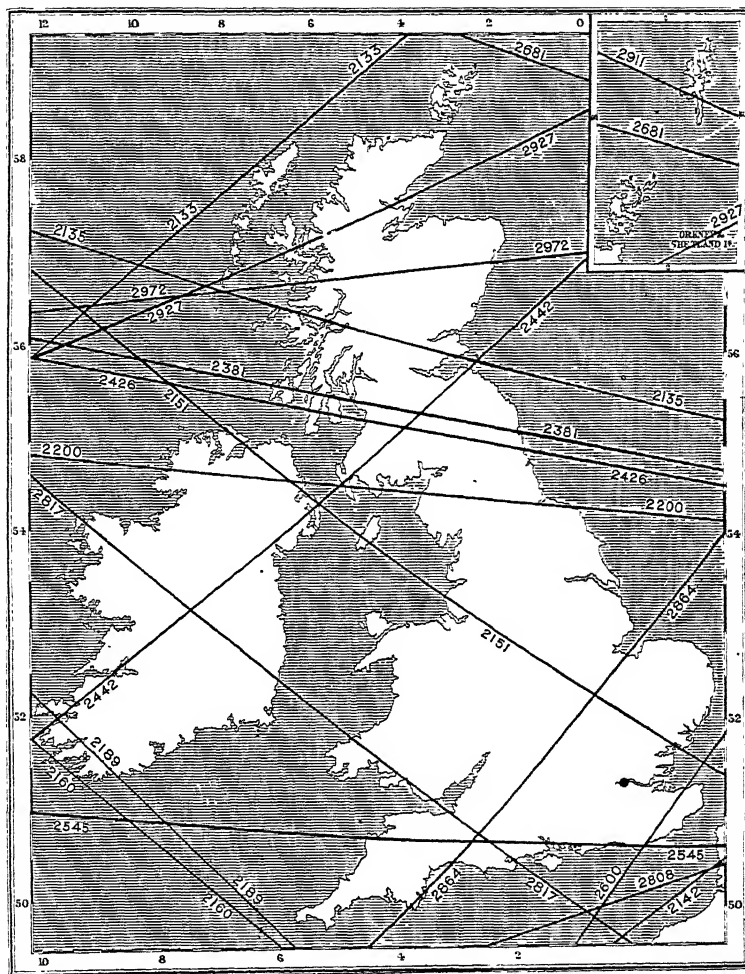


FIG. 2.

between British totalities: A.D. 2133, 2135, and A.D. 2972, 2974; three of a 7-year interval: A.D. 878, 885, and A.D. 1133, 1140, and A.D. 2135, 2142; six of a 9-year interval: A.D. 1424, 1433, and A.D. 1715, 1724, and A.D. 2081, 2090, and A.D. 2133, 2142, and A.D. 2151, 2160, and A.D. 2808, 2817.

Meteorological Conditions in Relation to Eclipse Observations.

By R. CORLESS.

THE eclipse of the sun which will occur at about 5 h. 23 m. G.M.T. (6.23 A.M. summer time) on June 29 will appear total to observers stationed upon a strip of country 28 or 29 miles wide, of which the central line stretches from

Criccieth in North Wales to Hartlepool in Durham. The character of the country included in this strip is very varied. There are coastal areas on the Llyn Peninsula and North Wales, in Lancashire and between Sunderland and Salt-

burn on the east coast; there are, on the other hand, the mountain peaks of Snowdon, Whernside, Pen-y-ghent, and many others; and there is a considerable gradation of hill, plateau, valley, and plain between these extremes.

It is worth consideration whether the climatological records suffice to indicate which type of country in the belt is likely to provide the most favourable weather conditions for viewing the eclipse. The question resolves itself into the identification of the places which, on the average, are most free from cloud, mist, and fog. The records do not furnish a direct answer to this question, because observations of cloud are not sufficiently numerous and well distributed along the belt to define with precision the average distribution of cloudiness. A consideration of other records, notably of rainfall, sunshine, and visibility, indicates, however, that the conditions which produce bad seeing are so different in character on different occasions, that it is better not to deal with averages, but to classify the various occasions into types, and to consider the physical conditions associated with different types.

A broad classification can be made into the following occasions:

- (1) When seeing is bad everywhere.
- (2) When it is variable.
- (3) When it is bad on the hills and good elsewhere.
- (4) When it is bad in the low-lying valleys and good elsewhere.
- (5) When it is good everywhere.

(1) Occasions when seeing is bad everywhere are most likely to occur when a widespread canopy of cloud is produced in a depression or region of relatively low barometric pressure. But they also occur in certain anticyclones where an inversion of temperature at a moderate height prevents vertical motion of air, and so favours the development of a layer of cloud just below the inversion. In the latter case the summits of mountains may be places from which a good view can be obtained.

(2) The condition in which seeing is variable and changeable is characteristic of a depression of less intensity than that of the previous case. Especially in the rear of the disturbance the weather may be showery, and bands of cloud may alternate with stretches of relatively clear sky.

(3) The third case, in which seeing is bad on the hills and good elsewhere, is in general due to the formation of persistent cloud on and above the hills as a result of the lowering of temperature in a current of rather moist air, which is forced upwards by the obstacle of the hills themselves. The clouds disappear on the lee side of the hills because the temperature of the air-current increases again in its descent after surmounting the crest. In this case a definite air-current is an essential part of the process, and as wind is detrimental to fog formation, mist and fog are not normally found at low levels.

(4) In this case seeing is bad in the low-lying valleys, in consequence of the development of mist or fog, but good elsewhere. This condition is characteristic of the early morning in anticyclonic, cloudless summer weather. It arises from the cooling of the ground by radiation to the clear sky during the previous night, which leads to the cooling of the surface layers of air by conduction. Conditions being anticyclonic, there is usually little or no wind, consequently the cold surface air flows into the valleys by gravitation. The temperature of this air continues to fall as the night progresses, until by daylight it is probably below the dew-point, and the cold air is co-terminous with a sea of fog with a flat, well-marked top, which is fatal to good seeing for observers enveloped in it. Above the fog the air is clear and cloud is usually absent.

(5) The fifth case provides the most favourable conditions for good visibility everywhere. It differs from the last in that fog is not formed in the valleys because air movement in the anticyclone is sufficient to overcome the tendency of the chilled surface layers to gravitate into the valleys. Mixing of the lower layers by turbulence takes place and prevents the temperature from falling to the dew-point. Meteorologically the two cases are not readily distinguished, but the results are very different to observers stationed in deep valleys.

In the absence of information as to the probable distribution of barometric pressure on the morning of the eclipse, the only practical conclusion that can be drawn is that it is advisable to avoid both high ground and very low ground. But on the day prior to the eclipse it should be possible, with the aid of the current weather map, to form an opinion as to which of the five general conditions of weather described above is likely to be experienced on the following morning.

Naked-Eye Observations of an Eclipse of the Sun.

By ANNIE S. D. MAUNDER.

NO observer of the partial phase of a total solar eclipse should look at the sun with the naked eye. During this phase some people advise the use of coloured gelatine spectacles, smoked glass, or darkened photographic film; others advocate a graduated screen, using always the densest possible part of it. A very serious attitude is taken in the *Lancet* of April 30, where two ophthalmic surgeons urge that the public must be made to understand that neither smoked glass nor fogged photographic film are safe screens even when well prepared, seeing that they do not absorb the irritant ultra-violet rays, and to avoid the risk of 'eclipse blindness' use must be made of a photographic film which (after fogging so as to obtain the necessary density) has been treated by a special process which excludes wave-lengths shorter than 4000 Å.U.

My own precautionary method is at once safer, cheaper, and more effective. It is this: Do not look at the sun at all—either with the eyes screened or unscreened—until totality is just about to begin. During the partial phase there is nothing on the sun of interest that cannot be seen better by looking on the earth. In other words, project in all cases the sun's image on a screen—white card, ground glass, pavement, or wall—whether the projection be through a telescope, or the 'pinholes' made in a cardboard, or between the leaves of a tree. (Projection, on ground glass or white cardboard, through a telescope, is of course the best way for timing the four contacts of sun and moon.) The little 'decrecent' or 'crescent' suns upon a wall or pavement are very pretty to watch and can easily be photographed. Nor is it the image only of the sun itself that becomes bow-shaped, but also the shadows cast by it. I first noticed this in the very large partial eclipse of 1912, seen in Paris, as an eclipse something between total and annular, when the sun was high in the heavens at noon, and standing on the flat roof of a house in Greenwich, I looked down on my shadow far below on the pavement. This showed my ears pointed like the traditional faun's; and, more curious still, when I stretched out my open hand, all my fingertips were drawn out and bent like a bird's claw.

By the time that the sun has become a narrow bow in outline, and there remain but a few minutes, perhaps three or four, before the actual beginning of totality, the shadow-bands should begin to dance in streaks or wavy lines. I have heard these compared to many things, but I have never had the

good fortune to see them myself: to the shadows of the ripples on the surface of the clear water dancing on the shingly beach below: to the shadows cast on the wall of a room from rippling sunlit waters outside. In the words of Mr. C. L. Brook (at the 1900 eclipse), "ripples raised on water by a bright breeze represent best what may be termed the structure of the shadows; they all move in the same direction, each ripple element is linear in character but retains its individuality only for a moment, appears to dissolve away and others take its place." In the Australian eclipse of 1922, some observers saw a flickering shadow hovering over distant trees eleven minutes before totality; later, on the ground, round their feet: "they flitted under the trees as the shadow of a bird might when flying above." Immediately after totality, the whole light was crimson for about ten seconds, and *red* and *black* shadow-bands raced over the ground. The bands were seen by chromospheric, not by sunlight. From the scientific point of view, the ideal occasion for their observation was in the American eclipse of January 1925, when Nature itself provided a white carpet for them to dance upon. It has been thought that they were due to currents in our upper atmosphere and that we could learn from them something about this; but the Americans observed them too closely and found that they were wind swirls—little 'devils' they are called in India—close to the ground, and in one place were seen to be chasing one another in all directions round a tree.

Whether the onrush of the moon's shadow can be seen at the coming eclipse will depend on whether the weather is clear or hazy. At the American eclipse it was looked for, but was undefined because of the haze. Major Hepburn says that this is the most impressive feature of the spectacle: "the onrush from a certain direction of rapidly spreading and engulfing darkness." But those who have work to do during totality have to forgo this experience.

The eclipse of June 29 is a young one; it is total—and not very much total at that—for the first time; when it is a Saros older it will be better. As a consequence, the chromospheric ring will probably be visible throughout the whole period that the sun's disc is covered. The form and size of the corona will depend on the actual state of activity of the sun at the moment. If there are many and great sunspots and prominences, and if these are near the sun's edge, then we may expect a complex

inner corona, which, however, will only show to the naked eye as a bright silver ring surrounding the narrow pink circlet of the chromosphere, with long coronal streamers extending in all directions; if there are no spots and insignificant prominences on the sun, then the coronal wings will lie folded along the sun's equator. Prominences, of course, will be visible to the naked eye only if large enough; keen sight could detect a prominence of 40,000 miles height; one of 200,000 miles should be easily visible. The corona will be ivory or white in colour; the chromosphere will be rosy; prominences will probably be red, but they may be white.

We would wish for June 29, that the weather on the sun should be stormy with many eruptions; that—for naked-eye observers—there should be deep lunar valleys near the points of second and third contacts; and that great red prominences should show up where these lunar valleys are.

In the American eclipse of 1925, New York City had a very beautiful aspect of the eclipse, which there was of short totality. The eclipsed sun showed as a faint circle of light with an intensely brilliant place at one spot, the rays from which spread out and gave the impression of a ring with a big diamond inserted in the usual way. There was a depression in the moon's edge which grazed the edge of the sun for some time, as seen from New York, which lay on the edge of the shadow track, just as Liverpool lies (probably) on the edge of the shadow track on June 29 next. In one of the Russian chronicles there is a description of the eclipse of May 1, 1185: "In the evening there was an eclipse of the sun. It was getting very gloomy and stars were seen, and in the men's eyes was a green light. The sun became similar in appearance to the moon, and from its horns came out somewhat like live embers"; which seems to point to something like the 'diamond ring,' perhaps a prominence as well as sunlight.

I have myself only once seen the eclipsed sun with the naked eye, and then it seemed small, much smaller than the full sun and moon to which I have been accustomed. But this was in India, with the sun high in the heavens. Mr. H. B. Adames saw the beginning of the eclipse of 1905 as the sun rose over Lake Winnipeg, and to him the entire body of the moon, which suddenly appeared with a blood-red prominence on either side, was a "huge black ball immensely exaggerated."

The effect of the rapidly diminishing sunlight on land and sky is weird and uncanny; all life and warmth fade out of the landscape; the flowers look withered, the grass and trees lose all trace of their living green and become of a dull lead colour; even the very faces of the observers become livid. If the sky is blue, it changes to a deep funereal purple. If there are small clouds near the sun, the iridescent colours, which are always there but not always easily seen, stand out vividly as in a spectrum. Round the horizon—which is near or beyond the shadow's edge—there is a glow of an angry gold, a sulphur light, not untinged with red. These are sunset effects, perhaps, which become visible when the daylight is cut off, but they may owe something also, as Mr. C. T. Whitmell suggested, to the red chromospheric light. If clear, it will be well to glance at the shadows cast by the corona; in 1922, Miss Miriam Chisholm found that these, though present, were undefined.

In my opinion, all naked-eye observers who are artists should make the painting of the colour effects on land, sky, and sea their chief study at this eclipse. It is not, of course, possible to do this work actually in the short totality, but the outline should be drawn before the eclipse, the colours noted during the total phase, and the painting finished afterwards while the tints are still fresh in the memory. Like meteorologists, artists get their results, whether the eclipse is clear or cloudy.

Eclipse Photography.

By C. P. BUTLER.

ALTHOUGH the total solar eclipse on Wednesday, June 29, will be one of short duration—about 23 seconds total obscuration in England, and 30 to 40 seconds in Norway—the improvements in sensitivity of photographic materials and design of optical equipment warrant the attempt to obtain photographic records of various stages of the phenomenon. In order to give information wanted by observers having diversity of equipment, we may briefly summarise the various means with which observations may usefully be undertaken.

Ordinary Cameras.—These may range from the modest hand-camera to the largest field or studio apparatus, preferably fitted with some controllable exposing apparatus other than merely the lens cap. These may all give interesting pictures, but the scale of the result will be strictly proportional to the focal length of the lens employed. The diameters of the sun and moon are about half a degree of arc on the sky, so it is a simple matter to calculate what the actual linear diameter of the image of the eclipsed sun will be with any given

lens; an ordinary camera of, say, 7 inches focus, will give an image about $\frac{1}{16}$ inch diameter; one of 12 inches focus an image about $\frac{1}{16}$ inch diameter. In spite of the small scale, such lenses in previous years have given very beautifully defined pictures of the eclipsed sun and the surrounding corona. For the delicate outer streamers of the corona such apparatus is very efficient, and possibly more suitable than the larger scale instruments. This was illustrated by the success of Mrs. Maunder at the eclipse of 1898 in India, when the photographed coronal streamers extended about eight solar diameters from the edge of the moon. In this work of photographing an illuminated area, the power of the lens is regulated by the ordinary f value, i.e. the ratio of aperture to focal length, so that lenses with the largest a/f value available should be chosen for this occasion.

Telephoto Cameras.—By means of an auxiliary lens, generally concave, to reduce the bulk of the apparatus, increased focal lengths may be obtained with a given camera. Photographers having telephoto attachments to their lenses will be able to obtain large-scale pictures, but if the equivalent focal length is more than about 20 inches, some method of moving the camera with the sun will be necessary for exposures longer than a few seconds.

Long-focus Lenses or Telescopes.—These instruments are usually of larger aperture than a telephoto lens of similar focal length would be, so that, even when stationary, a useful picture may be possible with a snap-shot or short-time exposure. If furnished with clock-work drive, they provide perhaps the most important means of obtaining details of the structure of the eclipsed sun. Good results may be obtained by adjusting an ordinary camera, with lens set for infinity, immediately behind the eyepiece of a visual telescope which has also been adjusted on the distant object. If this arrangement is selected, it would be best mounted on a long, stiff board, and the whole fixed on a firm support pointing to the sun. The exposure should be made by rubber tube or antinous release, to avoid vibration.

Stationary or Clock-driven Apparatus.—With such a short eclipse it is doubtful if anything will be gained by installing temporary driving apparatus to follow the movement of the sun. Unless the utmost rigidity is secured, the small errors in fixing, driving, etc., may be greater than the actual movement of the object. The best advice appears to be that the camera should be firmly fixed on some rigid support, provided with a wedge adjusted to the elevation of the sun (about 11° in England).

With instruments of moderate focal length the movement during the possible exposures will be scarcely perceptible. The movement may begin to be effective when focal lengths of more than 20 inches are employed.

Alteration of Eclipse Track.—Notice should be taken of the recent alteration of the track of the eclipse and its time of occurrence. The latest calculations, kindly furnished by Dr. Comrie, of the "Nautical Almanac" Office (*Monthly Notices, Royal Astronomical Society*, vol. 87, April, p. 496), place the central line about *one mile farther north* than the previously published track, so that observers located near the southern limit as shown on the Ordnance Survey Map should move to some station at least two or three miles northwards, to be certain of complete obscuration. Observers near the northern limit of totality will be better situated in consequence of the alteration. The time of occurrence is only about 4 seconds later than the published time.

Perhaps a word here as to the actual method of observing the instants of totality will be welcome to those who have not previously seen a total eclipse of the sun. The moon commences to enter on the sun's north-western edge, about the position of 2-hours on a clock face as one faces the sun, and will gradually cross the disc in a slanting direction, roughly towards the 8-hour position. When near totality, about an hour after first contact, the sun will be 25° north of the east point of the horizon and at an elevation of about 11° above the horizon, these figures being slightly different at various localities. As the advancing edge of the moon gradually approaches the eastern edge of the sun, the intense white arc of sunlight will be broken into small beads, produced by the rough mountainous edge of the moon. The instant when the last of these bright spots disappears is the time of second contact, and denotes the beginning of totality. Unless the observer wishes to obtain a series of records, the exposure should not begin until this instant of second contact, otherwise the delicate features of chromosphere and corona will be lost in the bright glare.

It is advisable to protect the eyes with dark glasses, such as may be made from a densely fogged photographic plate, or ordinary deep-tinted neutral glass, until totality occurs. From second contact to third contact is the period of totality, which in England is expected to last for about 23 seconds. This is the time available for securing pictures of the corona, which can never be seen except in these special circumstances, and the exposures to

be given will depend on the number of pictures to be taken. In general it would be advisable to limit the number to three :

(i.) A snap-shot just after the last beads of sunlight are seen to disappear at the moon's eastern or advancing edge. This will give the prominences and perhaps the inner corona.

(ii.) A longer exposure of, say, 15 to 20 seconds, depending on the time occupied in changing plates.

(iii.) Another snap-shot just as the bright beads appear at the western edge of the black moon.

Cinema Record.—The eclipse, being of short duration, may be specially suitable for the taking of a cinematograph film of the various stages, in which case the exposures would be started some time before totality, to show the transition from partial to total phase.

Intending observers who are able to go farther afield will find the photographic conditions somewhat more promising in Norway, where the altitude of the sun during totality will be about 21° .

Photographic Plates.—In general it will be best for the photographer to use the plates to which he is accustomed. All the well-known brands of material, glass plates and films, are now so uniformly good with regard to clean working that any choice may be governed by whatever special features it is desired to obtain. If only one exposure is to be attempted, the most rapid emulsion is to be recommended. All the chief makers list plates from 350 to 650 H and D. For the corona much of the light is concentrated in a few special colours, violet, blue, green and red, the combination giving the silvery white sheen characteristic of the solar envelope. Ordinary plates, of whatever speed, will record only the violet and blue portions. To get the advantage of the visible colour action, panchromatic plates may be used. The outstanding plates of this variety are the Ilford Iso Zenith, Iso Wellington, and Imperial Eclipse Ortho, all being of the highest sensitivity and very clean working. Most makers also supply Spectrum Panchromatic Plates, which are of somewhat lower speed, but give a more equable representation of the spectrum colours. When the apparatus is fitted with lenses of large relative aperture, these plates may be used instead of those of greatest rapidity. The easiest way of treating these colour-sensitive plates is to develop in darkness for six minutes with the metol-hydroquinone solution recommended by the makers. For those, however, who cannot resist the temptation to enjoy seeing the image gradually built up, use may be made of one of the various desensitising

solutions which are now available. Before development, and in darkness, bathe the exposed plate in a weak solution of the desensitiser, such as phenosafranine, for about one minute. Then add the developer, and continue for a further six minutes, during which an ordinary safelight may be used to see the progress of development.

There is one possibility of difficulty, owing to the early hour (6 h. 23 m. A.M. British summer time) at which the eclipse will take place. If the sky is slightly hazy, the contrast of the silvery-white coronal structure may be lessened with respect to the sky background. With ordinary plates this cannot easily be remedied. But if panchromatic plates are employed, much of the sky glare may be eliminated by using a moderately tinted colour screen, of the type known as K_3 , which will cut out much of the blue glare, and yet pass sufficient of the green, yellow, and red to the panchromatic plate to give good density in the image.

Supersensitised Plates.—For observers with more experience, most varieties of plates may be hypersensitised by a preliminary ammonia bath. The plates are simply bathed in a weak solution of ammonium hydrate (about 1 per cent.) for one minute, at a temperature of about 50° F. (14.5° C.). Then dry the plate as quickly as possible, either by a centrifuge or a fan. All this should be done in darkness. If an alcoholic solution is preferred, the plate will dry much quicker, but the resulting sensitivity will be slightly lessened.

Films.—Observers desiring to use films may do so with every confidence; and as many film emulsions are now made colour-sensitive, the remarks already made as to using colour screens, if glare is present, also apply to films.

Colour Photography.—Many observers intimate their intention to try for colour records of the eclipse phenomena, for which several processes are available.

Backing.—It is advisable that all plates should be backed, as any traces of halation due to bright portions of corona, prominences, or slight cloud may otherwise diminish the delicacy of detail.

Shadow Bands.—In addition to the corona and prominences, there are several other features peculiar to a total solar eclipse which may be of interest to photographers wishful of a more extensive programme. Just before totality, and immediately after, a series of moving wavy shadows are usually seen on the ground or sides of buildings facing the eclipsed sun. The cause of these is not yet known with certainty, but they appear to have some relation to prevailing atmospheric conditions. If a white sheet or a whitewashed wall can be used,

photographs of these shadow-bands will be of value. Exact details of the position of the flat surface, whether horizontal or vertical, its direction with regard to north, south, etc., should be carefully noted. Also the actual width, rate of motion, and general direction of the bands on the white surface, and which way they move.

The Moon's Shadow.—This applies chiefly to observers who may be fortunate in occupying a hill station in Wales, Lancashire, or Yorkshire. The dense black shadow may be seen travelling over the landscape, and would form an interesting photographic study wherever possible. Only snap-shots may be made on this, owing to the great velocity of the moon's shadow over the earth's surface.

Landscape Colours.—Very varied descriptions of the remarkable changes of colour of landscape features have been noted during previous eclipses. Those provided with panchromatic plates or colour plates may do useful work in recording any of these changes. In such cases photographs of the same landscape under ordinary daylight conditions should be obtained to indicate changes due to the eclipse.

Spectroscopic Photographs.—So far we have only considered the photography of the eclipsed sun as a picture. There must be many observers who could photograph the spectrum of the phenomenon, and quite valuable records may be made with simple equipment. Either a prism or diffraction grating may be used, adjusted in front of the camera lens. In general this will involve some deviation of the pointing of the camera, which will have to be directed away from the line of the sun by an angle equal to the deviation produced by the prism, etc. Prisms and gratings can, however, be obtained which are arranged to give direct vision, and in such cases the procedure is exactly the same as with the camera lens alone. Very good results can be obtained with the replica gratings produced by the Thorp process, an additional feature being their relatively small cost compared with that of an original ruling on speculum metal. The photographic manipulation is identical with that for ordinary pictures, except that it is scarcely worth

using any except panchromatic plates, which will record the whole of the visible spectrum.

Time Records of Exposure.—The scientific value of any records obtained will be greatly enhanced if the instants of exposure are noted as accurately as possible. The track of the eclipse passes through such populated areas that few observers will be far away from some place where it should be possible to get facilities for listening to the standard time signals which will be broadcast from Greenwich and Paris. The well-known Greenwich six dots, the sixth indicating the time to be noted, will be broadcast at 6 h., 6 h. 15 m. and 6 h. 30 m. A.M. British summer time on June 29. (The latest arrangements for the broadcast time-signals will be found in "Our Astronomical Column.") Perhaps it would be a general convenience if the present 1.0 P.M. signals from Big Ben (12.0 G.M. noon) were given as Greenwich dots for the week preceding the eclipse. The Paris Observatory is also broadcasting from the Eiffel Tower (FL) rhythmic and other time signals specially for the eclipse on both spark and continuous wave.

Any records which can be made to the nearest second will be comparable in accuracy with the determinations of actual beginning and ending of the eclipse itself.

To summarise briefly :

- (1) Arrange for a steady support for the camera directed to the sun, special care being taken if there should be a high wind.
- (2) Provide the camera with a lens of as large a relative aperture as possible.
- (3) Use rapid plates, preferably panchromatic, with a light-yellow screen, and have the plates backed.
- (4) Exposures should be from snap-shot to about 10, 15, or 20 seconds for cameras up to 20 inches focal length. For longer cameras it is better to confine exposures to about 5 seconds, except in the case of clock-driven instruments.
- (5) For clock-driven apparatus take three exposures: snap for prominences at beginning, 15 to 20 seconds during totality for corona, and snap for prominences at end of total phase.

Radio Telegraphy and the Eclipse of the Sun.

SINCE 1912 observations have been made from time to time on the effect of solar eclipses on wireless signals. Up to 1925, however, the data obtained from the observations made was untrustworthy and contradictory, the reason for this being that the observations depended on estimates by the ear of the intensity of signal strength. Apart also from the absence of accurate and

suitable measuring apparatus, it is only in recent years that the mechanism of the propagation of waves round the earth has been understood to a sufficient extent to indicate the type of observation likely to yield positive results. The path of totality of the eclipse which took place on Jan. 24, 1925, crossed the United States, and the opportunity was then taken of arranging for a

network of observing stations on a comparatively large scale. At several of these stations galvanometer-recording methods were employed. During the same eclipse, observations of the field strength and direction of arrival of wireless signals transmitted from America were made in Great Britain. By that date also the theoretical work of Eccles and Larmor had provided a hypothesis of wave propagation by which the results obtained could be tested.

To understand the effect a solar eclipse is likely to have on wireless signals it is necessary to review briefly the manner by which it is now believed that electromagnetic waves are propagated through space. From any transmitting aerial part of the energy emitted is propagated horizontally along the surface of the ground and part is propagated in an upward direction into the atmosphere. The resistance of the earth has an absorbing action on the waves travelling over its surface. This absorption is least with long waves, and becomes very great in the case of what are known as ultra-short waves, that is, waves below, say, 100 metres. Owing to various cosmic influences, particularly radiation from the sun, the earth's atmosphere is ionised. During the daytime ionisation occurs at comparatively low levels, but with sunset recombination takes place in portions of the atmosphere where the gas pressure is fairly large, and by night, only the upper atmosphere at a height above 70 kilometres is left in an ionised state.

The effect of the ionisation of the atmosphere on electromagnetic waves has been shown by Eccles and Larmor to be twofold. First the electrons or ions present are set into vibration by the waves. As the electrons move they set up small electromagnetic waves out of phase with the original wave. The combination of the electric forces of these two waves causes the upper portions of the waves to appear to travel with a greater velocity than the lower portion, so that the wireless waves in the ionised medium are bent towards the earth. The amount of bending produced has been shown to depend on the intensity of ionisation and upon the square of the wave-length. Larmor has shown, however, that another effect of the ionisation present must be taken into account. This factor is the loss of energy due to collisions between electrons and gas molecules. This loss produces an absorbing effect on the waves passing through the medium, and in order that the effect may be small, the electrons must have a long mean free path; therefore the bending effect on the waves can only take place in the

upper regions of the atmosphere. It would be expected on this theory that the absorption due to the ionisation in the atmosphere would be less with very short waves of high frequency than with longer waves, since the time between a collision of an electron and a molecule will be greater than the frequency of the wave.

The general result is that upward radiation from an aerial may be pictured as struggling upwards through the absorbing lower atmosphere until it reaches a level at which it is bent round the earth without loss, again enters the absorbing layers, and finally reaches the earth once more. At night the absorption will be less, since the ionisation due to sunlight in the lower levels will be absent. Thus in general, wireless waves are propagated to greater ranges at night except in the case of extremely short waves, less than, say, 16 metres, the frequency of which is so great that the absorbing action is small, and a considerable intensity of ionisation is necessary to bend them round the earth. Such very short waves will therefore travel better by day than by night. It will thus be seen that, at short distances, a wireless receiver will be affected chiefly by waves which are directly transmitted along the earth's surface or through the lowest levels of the atmosphere; at intermediate distances the received signal will be the resultant of the direct ground wave and a wave travelling by the upper atmosphere; while at very long distances the effect on the aerial will be solely due to waves travelling through the upper layers of the atmosphere.

It follows from the above that the general effect of a solar eclipse should be similar to that of a sudden and very rapid sunset, followed by a sunrise. As the moon's shadow sweeps through the atmosphere, a recombination of the ions present will take place, with the result that the agencies producing the bending and absorption of the waves become confused and unsettled. A short time later, however, the lower atmosphere becomes clear of ions and night conditions prevail until the shadow passes on. The effect on the intensity of wireless signals during the eclipse should therefore be first a decrease in the average intensity followed by an increase. Broadly speaking, this was the result generally obtained in the 1925 experiments. The relative and absolute amplitudes of the drop and rise in signal strength were found to depend, however, on the position of the transmitting and receiving stations to the path of the shadow and on the wave-length used in the observations.

It appeared to the Radio Research Board of the Department of Scientific and Industrial Research that it was desirable that every endeavour should be made to use the opportunity offered by the eclipse on June 29 next for carrying out further observations on its effect on radio telegraphy. After discussion with other interests involved, a programme of observations has been drawn up which it is hoped will yield useful results. A point brought to the notice of the Board by Dr. E. H. Rayner, of the National Physical Laboratory, which has not previously been taken into account in eclipse observations, is that, as the altitude of the sun is low, the line on the earth's surface vertically over which that portion of the ionised layer lies in which the bending of the wireless waves probably takes place, is about 100 miles to the south-east of the line of totality on ground level. In the experiments to be carried out this fact is being borne in mind. In one set of experiments which are to be carried out under the supervision of Prof. E. V. Appleton, observations will be made by photographic recording apparatus on wireless signals crossing the line of ground totality—transmitted from Newcastle and received at Liverpool. Similar simultaneous observations will be made on transmissions from a station to the south of the ground totality line and received at the Radio Research Station at Peterborough.

The object of the experiments is in particular to investigate the height at which the bending of the waves by the ionised layer takes place during the eclipse and to endeavour to note the changes in the height of this layer. The method to be used is that described by Prof. Appleton in his paper in the *Proceedings of the Royal Society* (vol. 109, A, p. 621, 1925), whereby the wave-length of the transmitting station is varied through a small known amount (for example, 5-10 metres) in a given time (for example, 10-30 seconds), and the height of the layer is calculated by counting the number of interference fringes produced by the interference of the ground and atmospheric rays. The number of fringes produced depends on the path difference between the rays. From this number a simple calculation gives the height at which the bending of the rays takes place. It has been possible to arrange for the necessary transmissions for these experiments by co-operation with the British Broadcasting Corporation.

In connexion with previous work of the Radio Research Board, long-wave signal-strength measuring apparatus has been developed by Mr. J. Hollingworth and installed at the Radio Research

Station at Slough, at the University of Aberdeen, and at University College, Exeter. This apparatus will be employed for accurate signal-strength measurements on long-wave stations during the eclipse. The distance at which the ionisation of the atmosphere comes into play is greater in the case of long waves than with short waves. The necessary transmissions for observations on long waves are, accordingly, being arranged from continental stations under the auspices of the Union Radio-Télégraphique Scientifique Internationale. Long-wave intensity observations are also to be carried out with the apparatus developed by Prof. E. W. Marchant at the University of Liverpool.

Recent research has shown that the variable errors in radio direction-finding are due to the interaction of the magnetic fields of the ground and atmospheric waves. Under certain conditions these two forces give a resultant magnetic field not at right angles to the direction of the transmitter, and therefore an error in radio direction-finding apparatus is produced. The direction of the magnetic field of the atmospheric wave depends, it is believed, on the ionisation of the upper atmosphere and on the relation of the direction of transmission to the magnetic field of the earth. To test this explanation of directional errors, observations are to be carried out by a network of direction-finding stations observing transmissions from the London and Manchester broadcasting stations. Finally, accurate records of the intensity of atmospherics on a selected wave-length and of the direction of arrival of individual atmospherics are to be made at the Radio Research Station, Slough, and in Scotland.

In addition to the above experiments, which are being carried out directly under the supervision of the Radio Research Board, the Radio Society of Great Britain is arranging for observations by its members on transmissions on 90 metres from a station at Caterham and on transmissions on 100 metres from a station in Iceland. Arrangements are also being made for transmissions on 23 metres and on a wave-length between 44 and 46 metres. These two latter stations will be situated one to the north and one to the south of the line of totality on the ionised layer.

A difficulty which presents itself in connexion with the present eclipse is that totality takes place so early in the morning that ordinary sunrise effects may not have entirely ceased and may mask to some extent the eclipse effects proper. In order to prevent the confusion of any eclipse effects with those due to other causes, all the

observations proposed will be carried out on the mornings of the two days preceding the eclipse and on the two days following, in addition to the actual morning of the eclipse. The transmissions on which observations are made will extend for a period of two to four hours on each of these days.

How far the results of the experiments proposed will be valuable in checking present hypotheses of the propagation of wireless waves or in providing new information on this subject cannot, of course, be definitely stated beforehand.

O. F. B.

Astrophysical Eclipse Problems.

By Prof. H. DINGLE.

IF direct observation of the sun were our only means of investigating the form of our luminary, we should learn little more than that it is an incandescent rotating sphere. The spectroscopic makes possible the beginnings of a structural analysis by revealing an absorption spectrum—that is, a continuous spectrum crossed by relatively dark lines. This assures us that, broadly speaking, the sun consists of two portions—an interior responsible for the continuous spectrum, and an atmosphere the constituents of which selectively absorb some of the light of the interior, each according to its kind. Whatever can be learnt from the continuous spectrum characterises the interior, while the study of the dark lines—the Fraunhofer lines—is the study of the atmosphere. In the ordinary solar spectrum, of course, both continuous and dark line spectra appear together. Neither can be obtained, in the first instance, apart from the other, so that the separate analysis of ‘interior’ and ‘atmosphere’ is greatly complicated. Some measure of success has nevertheless been achieved; for example, the effective temperature corresponding to the light from the interior has been determined from the continuous spectrum, while the spectroheliograph affords some knowledge of the distribution of a few types of atom in the solar atmosphere. But on the whole it may be said that the inevitable association, in the ordinary solar spectrum, of the atmospheric lines and the photospheric background is a great hindrance to the complete study of the respective regions of the sun—and particularly that of the atmosphere.

Observations of the sun’s limb, where the atmosphere might be expected to appear alone and to show a bright line spectrum, reveal only that it is too thin (in angular measure) to do so. Even the spectroscopic method devised independently by Lockyer and Janssen in 1868 shows only the higher reaches of the atmosphere at the limb, and it was not until 1896 that it was finally established that there exists a bright-line limb spectrum at all comparable with the Fraunhofer lines. Since that time the long-focus instruments at the Mount

Wilson Observatory have given images of the sun with sufficient depth of atmosphere for the bright line spectrum to be observed, but when produced in this way the lines are still encumbered by the Fraunhofer spectrum, and the facilities afforded for detailed study of the solar atmosphere leave much to be desired. Only during a solar eclipse, when the photosphere is at least partly obscured by the moon, can a pure atmospheric spectrum be obtained, so that for our knowledge of the structure of the sun’s atmosphere—the solar meteorology, as it may be called—we still rely mainly on eclipse observations.

Three aspects of the bright line, or ‘flash’ spectrum, are studied in modern eclipse research; namely, the wave-lengths of the lines, their relative intensities, and the distribution in the solar atmosphere of the atoms or ions responsible for them. It appears probable that the determination of wave-lengths will in future be attempted only by the method described below (p. 91) by Prof. Fowler, for which totality is not necessary. It need not, therefore, be referred to here except to point out its uses in the identification of the lines and the recognition of disturbing influences in the event of displacements being established with respect to terrestrial standards or the Fraunhofer spectrum. Two facts must be borne in mind in this connexion. First, the Fraunhofer spectrum is observed more or less radially, and the flash spectrum tangentially, so that there may be differences in the thickness and state of motion of the regions of the atmosphere observed; secondly, the lowest layers of the atmosphere can be observed only through an envelope of the higher layers, and any difference of wave-length at different levels will broaden the lines and possibly give rise to unsymmetrical reversals when the lines are examined microphotometrically.

The question of the relative intensities of the lines has greatly increased in importance with the development of modern spectroscopic theory. It is intimately bound up with the question of the distribution of atoms and ions in the sun’s atmosphere; for the intensity of a spectrum line depends

both on the number of atoms of the proper kind which are present, and on the physical conditions tending to make them emit that particular line. It is necessary, therefore, not only to compare the relative intensities of different lines, but to investigate also the variation in intensity of each line in different regions of the atmosphere. Since it is only the atmosphere at the limb which is being studied, this is equivalent to a determination of the variation of intensity along each line, supposing a radial or tangential slit to be employed.

This investigation is attended by considerable difficulties. Not only is there the complication already referred to (namely, that the ends of the lines representing the lowest levels may contain light from the higher levels also), but also the diffused light in the earth's atmosphere tends to fill the slit and make the distribution of light in the spectrum line differ from that in the corresponding regions of the sun's atmosphere. This effect is very pronounced in misty weather, and on such occasions, when a radial slit has been used, bright lines have been observed to extend even over the whole diameter of the dark moon. Objective prism spectrograms (*i.e.* spectrograms obtained by placing a prism before the object glass of an astronomical telescope, and using neither slit nor collimator) in which each 'line' is a crescent image of the region of the solar atmosphere emitting the corresponding wave-length, do not suffer from this defect, for the diffused light, entering the telescope from all directions, is simply spread over the photographic plate to produce an imperceptible fogging. In these spectra the lengths of the arcs measure the heights in the sun's atmosphere reached by the corresponding emitting sources, but irregularities in the moon's limb and other interfering agencies invest the results with a considerable amount of indefiniteness. All photographic methods of attacking this problem have to cope with the further difficulty of non-uniform sensitivity of the plates to light of different wave-lengths; thus, two lines of the same length in different parts of the spectrum do not necessarily arise from emitting sources similarly distributed in the sun's atmosphere. Results obtained from many eclipses will have to be carefully analysed and compared before trustworthy conclusions in any degree of completeness can be reached.

The beautiful photographs obtained by Merfield at the eclipse of January 1926 suggest that the method employed by him (it was in part proposed also by Lockyer in 1896, but clouds prevented the

trial) might yield valuable results. It consists in photographing an objective prism flash spectrum on a plate moving uniformly at right angles to the direction of dispersion, immediately in front of the plate being a narrow slit, lying along the spectrum, so as to reduce the instantaneous image of each 'arc' practically to a point. The resulting spectrum then appears as a set of parallel lines of various lengths, and it is proposed to determine the heights reached by the corresponding emitting sources from a measurement of the rate of change of intensity along the lines. It remains to be seen what degree of success the method is capable of yielding when the actual determinations have been made.

When the general distribution of the various types of atom and ion in the solar atmosphere has been reliably determined, the application of recent spectrum theory will give much information concerning the physical conditions existing there. A particular investigation of this character is being undertaken on June 29, in which attempts will be made to determine the relative intensities in the chromosphere of the Ca^+ diffuse 'doublet' at $\lambda\lambda 8498\text{--}8662$ in the infra-red, and the bright counterparts of the well-known H and K Fraunhofer lines in the violet. The result should have considerable significance in connexion with the theory of the calcium chromosphere proposed by Milne. Photographs extending still further into the infra-red, up to about $\lambda 15,000$, are also to be attempted.

These eclipse researches into the constitution of the sun's atmosphere are of great interest and importance, but they must always play second fiddle to the study of the corona, because it is only during a total eclipse of the sun that the corona can be observed at all. The investigations referred to above are greatly facilitated by the intrusion of the moon, but they could be carried out in some manner if the moon did not exist. (It must not be forgotten, however, how much the methods employed on the uneclipsed sun owe to knowledge gained originally from eclipse observations.) But if there were no moon, or if the moon were slightly farther from the earth than it is, we should not to this day suspect even the existence of the corona. It is obvious, therefore, that whatever else may be neglected at a total eclipse, all possible information must be obtained with regard to the corona.

Our absolute knowledge of the corona may be summed up very briefly. It is an intricate solar envelope the form of which varies with the phase of

the sunspot period, while its light, which is partly polarised, consists of a combination, in varying proportions, of unknown bright lines, continuous spectrum, and Fraunhofer spectrum. Considering that the corona is observable, on the average, for at most about three minutes every two years or so, it is not surprising that our knowledge of it is so rudimentary. Single observations have no definitive value; they need confirmation at subsequent eclipses. In the case of the corona they have perhaps more often been contradicted, so that uncertainty exists whether the observations are at fault or whether the corona has changed. In these circumstances progress is necessarily slow, and many records must be accumulated before conviction can be reached.

A record, as complete as possible, of the form of the corona at each observable eclipse has been kept for some years, and must of course be continued indefinitely. In time this should reveal any obvious periodic changes of form or structure which may exist in addition to the already known relation with the sunspot period. The connexion between the corona and the solar prominences might also be elucidated from such a record. The difficulties, however, are enormous, for not only are there long gaps between successive photographs or drawings, but also at each eclipse the coronal light seen is at each point an unanalysable integration of light emitted along a chord of the coronal shell, and does not represent a simple plane section of the shell. The changes in the form of the corona appear to be slow. Attempts have been made to detect them by observing the same eclipse near sunrise and sunset, but the results are inconclusive. Further attempts are desirable. For such observations to be successful there must be convenient sites near the two ends of the belt of totality and the sun must be unclouded at both stations—a combination of circumstances which very rarely occurs.

The total light of the corona still awaits a satisfactory determination. It no doubt varies from one eclipse to another, and might be correlated with the sunspot period. Still more important, perhaps, is the law of variation of light with distance from the sun's limb. Several widely differing formulæ have been proposed, and here again there are probably changes from one eclipse to another. The heat radiation of the corona was measured by Abbot in 1908, but further determinations would be of much value. The very delicate apparatus designed by Callendar for use in the 1905 eclipse, which was spoilt by clouds,

might give valuable results in this direction of research.

The spectrum of the corona and its connexion with the sunspot period are as yet very imperfectly understood. The portion of the light which gives a Fraunhofer spectrum comes from the middle and outer corona, and is undoubtedly reflected or scattered sunlight. Experiments on the amount and kind of polarisation of this light at different distances from the sun's limb are necessary to afford an insight into the mechanism of the reflection or scattering, and hence into the physical constitution of the corona. Such experiments have been made at many previous eclipses, but the difficulties of interpreting the results are so great that further investigations by the most trustworthy methods are necessary. The continuous spectrum of the inner corona may also be due to photospheric light, but there are reasons for thinking that it originates in the corona itself. Confirmation is difficult, but the evidence most obviously necessary is that of the curve of distribution of energy throughout the spectrum.

The line spectrum of the corona offers perhaps the largest field for investigation. None of its lines has yet been recognised in the laboratory, and its composition is very uncertain. Much progress has been made in disentangling it from the chromospheric spectrum, but finality has not yet been reached, and the faintness of the spectrum makes it almost certain that the present lists of lines are far from complete. Variations in the relative intensities of the lines at different eclipses suggest that it is a superposition of two or more spectra. Several attempts, on numerical as well as observational bases, have been made to classify the lines into groups, but the results so far are not consistent. The spectrophotometric measures initiated by the British expedition to Sumatra in January 1926 indicate a promising method of classification in terms of the variation of intensity along the lines. When such data have been obtained at a number of eclipses, accidental similarities can be eliminated and possibly definite conclusions arrived at.

The precise wave-lengths of the coronal lines are important for both laboratory identification and measurement of motions in the line of sight. There is so little agreement as yet between the various sets of measures available that further determinations with the highest possible degree of accuracy are of the greatest importance. It may be hoped that Prof. Fowler's experience this month

with high-dispersion photographs of the 'flash' spectrum will show that the same method is practicable with the corona—at least so far as the brighter lines are concerned. The line spectrum of the corona appears to be relatively brighter at maximum than at minimum of the sunspot period, so that the coming eclipse should be favour-

able for the various investigations connected with it.

It will be realised that the outstanding astrophysical eclipse problems are 'many and various.' We may reasonably hope that, granted fair weather, our English eclipse will lead to important extensions of our knowledge of the sun.

Spectroscopic Observations during a Partial Eclipse of the Sun.

By Prof. A. FOWLER, F.R.S.

IT is common knowledge that the chromosphere and prominences which surround the visible surface of the sun cannot be seen in the telescope at ordinary times because they are less bright than the diffused light of the sky on which they are superposed. They can, however, be observed by combining the telescope and spectroscope in the manner discovered by Lockyer and Janssen in 1868. The spectroscope being adjusted on the bright red line of hydrogen ($H\alpha$), and an image of the sun being focussed tangentially to the slit, the diffused sky light is spread out into a continuous spectrum (crossed by dark lines) and is thereby so much reduced in intensity that the bright hydrogen line from the chromosphere, or from a prominence, becomes easily visible. To see the actual forms of the chromosphere and prominences, it is only necessary to open the slit rather wide.

Other bright lines besides $H\alpha$, including the yellow line of helium, D_3 , and the hydrogen line $H\beta$, may be observed in the same manner, but they are not numerous when instruments of moderate size are employed. Spectroscopic observations with large telescopes at ordinary times, or with ordinary instruments during total eclipses, however, have shown that as the sun's edge is approached the bright line spectrum increases in complexity and finally exhibits a multitude of bright lines which originate in a region extending less than two seconds of arc above the photosphere, the apparent diameter of the sun being nearly two thousand seconds of arc.

When observations are made near the central line during a total eclipse, the spectrum of this shallow layer suddenly bursts into view at the beginning of totality, and almost as quickly disappears; it reappears for two or three seconds just before the end of totality, at the point of contact of the sun and moon. On account of its brief duration under these conditions, the spectrum of this shallow layer which surrounds the sun has been called the 'flash spectrum,' and the layer itself the 'flash stratum.' It is here that a large proportion of the absorption which produces the dark Fraunhofer lines of the

ordinary solar spectrum takes place, and the flash stratum is accordingly also known as the 'reversing layer' of the sun.

Overlying the reversing layer, but not sharply divided from it, to a total height of about ten seconds of arc above the photosphere, is the chromosphere. This has not a smooth continuous surface,

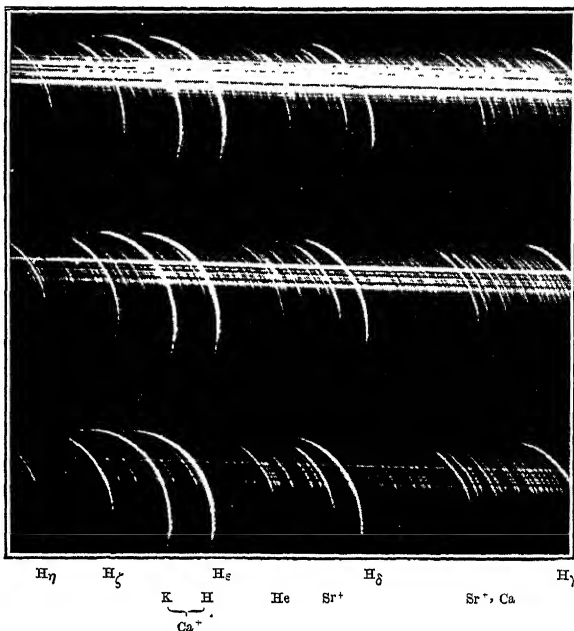


FIG. 1.—Flash spectra: portion of the first large plate taken with a 6-in. prismatic camera in India, 1898. By Prof. A. Fowler.

but is roughly serrated, and the prominences, which are sometimes very brilliant and reach to enormous heights, rise out of the chromosphere.

On ordinary occasions, with telescopes of moderate size, it is not possible to observe the spectrum of the reversing layer, because of the 'boiling' due to atmospheric tremors, which blends the bright lines from the thin stratum with the brighter spectrum of the edge of the sun's disc. Occasionally, however, there is a disturbance at some place near the sun's limb, and the reversing layer may then be so far elevated that a large number of bright lines can be differentiated from the photospheric spectrum. With the large instru-

ments available at the Mount Wilson Observatory, bright lines have been photographed in large numbers without an eclipse, but even here the flash spectrum is somewhat confused by that of superposed sunlight.

It is during total eclipses of the sun that the flash spectrum can be most effectively observed. The reversing layer is then revealed for a brief time on a comparatively dark background, with no interference from the bright disc of the sun. Its spectrum has frequently been successfully photographed by the use of slit spectrographs of ordinary type, and by the use of prismatic cameras or slitless spectroscopes. With the latter form of spectrograph a spectrum taken near the beginning of totality consists of a succession of curved images of the portions of the chromosphere and reversing layer visible at the moment of exposure, each representing a spectrum line, and having a length depending on the height of the gas or vapour which produces it. The nature of such photographs will be gathered from Fig. 1, which reproduces a small part of a plate containing ten such spectra taken at intervals of about one second, beginning a few seconds before the commencement of totality in India in 1898. In these photographs the reversing layer is represented by the numerous short arcs which appear in the middle of each spectrum, and the chromosphere by the longer arcs, among which those of calcium H and K, hydrogen and helium are very conspicuous. The bright streaks of continuous spectrum originate from specks of the sun's disc which were visible through irregularities in the edge of the moon.

Such photographs bring out many important features of the bright line spectra, but for various reasons they do not yield wave-lengths of a high degree of accuracy. Excellent photographs have also been secured with slit spectrographs, but in observations during totality, the dispersive power which can be utilised is limited by the short duration of the phenomena.

In order to obtain an increased duration of the flash spectrum, Evershed, in the eclipse of 1900, selected a station near the edge of the zone of totality. In these circumstances it will easily be understood that the dark moon must glide tangentially with respect to one point on the sun, so that the flash spectrum can be effectively observed near that point for a considerably longer time than from a place near the central line. Thus, using a prismatic camera, Evershed succeeded in obtaining good photographs of the flash spectrum during a period of about half a minute, and the illumination of the

sky throughout this period was sufficiently reduced to allow of the fainter lines being registered on the plates.

Observations of the large partial eclipse which was visible in England on April 17, 1912, indicated another means of observing the flash spectrum for a comparatively long time, and suggested that photographs might be taken with instruments of large dispersion, comparable with those used for the sun itself. This possibility is opened up by the fact that at the cusps of the partially eclipsed sun the flash and chromospheric layers project to a greater distance than their radial depths. This will readily be understood from the diagrammatic representation in Fig. 2.

At South Kensington the magnitude of the

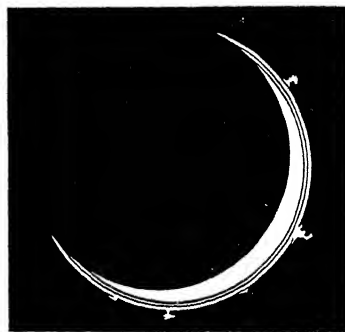


FIG. 2.

eclipse of 1912 at central phase was 0.92, and visual observations by Fowler showed that the flash spectrum could be effectively observed at the cusps during about thirty minutes. Some gain in visibility of the bright lines was first noted when the magnitude of the eclipse was 0.55, while the apparently complete flash spectrum was visible when the magnitude of the eclipse was 0.8 or greater (*Monthly Notices, R.A.S.*, 72, 538). Similar observations were made at Cambridge by Prof. Newall (*Monthly Notices, R.A.S.*, 72, 536).

In view of these observations, it seems possible to employ spectrographs of greater power than any hitherto used in eclipse work, and to impress comparison spectra for the accurate determination of wave-lengths. It may thus be hoped to obtain data for the investigation, among other things, of possible small displacements of the bright lines such as are already known in connexion with the Fraunhofer lines.

It was intended to make this experiment in Russia on Aug. 21, 1914, but owing to the outbreak of the War the expedition had to be abandoned, and the instruments were not returned to England until 1924. It is now planned to employ practically the same equipment during the eclipse of June 29 this year.

Although slightly better conditions might be obtained by the occupation of a station somewhat nearer the central line of eclipse, the instruments are being erected on the roof of the Imperial College of Science at South Kensington. The magnitude of the eclipse there at central phase will be 0.96, and the experience of 1912 indicates that this will be ample for the purpose in view. Any advantage likely to be gained by going farther north would, it is thought, not sufficiently compensate for the loss of the facilities afforded by the College laboratories and workshops. Prof. Sampson has also taken this view and will attempt similar work at the Royal Observatory, Edinburgh, where the greatest magnitude of the eclipse will be 0.98.

A large partial eclipse also provides a very favourable opportunity of investigating the spectrum of the sun near the limb. The observations at Mount Wilson have already shown that this spectrum differs very considerably from that given by the centre of the disc, but observations during a large

partial eclipse may have the advantage that there will be no scattered light from the central parts of the disc superposed on the light emanating from near the sun's edge.

The spectrograph to be employed at South Kensington has a concave grating of 10 feet radius in an Eagle mounting, and will be adjusted for the second order spectrum so as to avoid undue astigmatism. An image of the sun about 2 inches in diameter will be formed in the plane of the slit by a 6-inch objective, which will receive light from a cœlostast after reflection from a second mirror. Adjustments are provided for maintaining the image of a cusp on the desired part of the slit, and it is expected that the exposures required will not be so long as to cover an undesirable range of solar latitude as the cusp changes its position on the sun. The requisite astronomical data for South Kensington have been specially computed by Dr. L. J. Comrie of the "Nautical Almanac" Office.

The Forms of the Solar Corona and their Origin.

By Dr. WILLIAM J. S. LOCKYER.

IT is only during total solar eclipses, when the moon comes exactly between the earth and the sun, and cuts off all the brilliant light of the disc, that an outer solar atmosphere of an exquisite pearly hue known as the 'corona' is revealed. Without such eclipses, this atmosphere, even with the aid of any of the great and ingenious optical means available to-day, would still be unknown. The corona is of very considerable extent, far exceeding, in proportion to the size of the solar disc, that of our own in relation to the size of the earth.

It is well known that the form of the corona varies in shape and brilliancy very considerably. Sometimes the form is very irregular, the coronal matter being extensively distributed all round the solar disc, embracing both the solar poles and the equator. This form is termed 'polar,' 'irregular,' or 'maximum,' as coronal streamers are situated near the solar poles (Fig. 1).

On other occasions the polar regions are conspicuous by the complete absence of streamers, and in their place beautifully curved rifts or plumes are seen, the long streamers being restricted more to the equatorial regions. This type of corona is termed 'equatorial' or 'minimum,' and is sometimes referred to as of a 'wind-vane' form, as it resembles this object (Fig. 2).

Finally, there is a third and also very pronounced

shape which is intermediate between the above two forms. This is termed the 'intermediate' type or 'square' corona. In this case the streamers are generally concentrated in mid-solar latitudes, leaving the poles and equator comparatively free from any large coronal extensions.

The use of the terms 'maximum' and 'minimum' with regard to the shape of the solar corona referred to the epochs of sunspot maximum and minimum, and it suggested a connexion with the periodic variation in the spotted area of the sun's surface. Until a few years ago, it was generally concluded that sunspots were therefore the origin of the coronal forms, and their waxing and waning was reflected in the changes of these forms.

Sunspots, however, do not appear at or anywhere near the solar poles; the highest latitude they ever attain is only 45°, and then they are only of very small area. On the other hand, large coronal streamers and prominent rays are sometimes situated in very high latitudes; in fact, at times they are very near or at the poles, and consequently quite outside the regions of spot activity.

Moreover, at the epochs of greatest spotted area, the mean latitude of spots is only about 18°; yet it is precisely at about those epochs that the coronal streamers appear at the poles, and the coronal forms are described as 'maximum' or 'polar.'

These facts suggested to me in 1903 that the prominences, which are not only very important disc, but are strictly confined to a belt which lies approximately between latitudes 45° and 5° on both sides of the equator. Sunspots, therefore, never occur at or near the solar poles. The mean yearly positions of these belts are shown in the third series of curves illustrated in Fig. 3. The latitudes of sunspots are closely associated with sunspot frequency. When there are most spots their mean latitude is about 18° : when there are fewest spots their mean yearly latitudes are about 22° and 8° . The formation of high latitude spots near a sunspot minimum heralds the commencement of a new cycle of spot activity.

In the case of solar prominences, their appearance waxes and wanes very closely with the sunspots, as is indicated in the second curve of Fig. 3. When there are numerous spots there are many prominences, and vice versa. There is, however, a very big difference between their behaviour as regards solar latitude.

Prominences can occur in any part of the sun, and they can be as large and conspicuous at the poles as they may be at the equator.

factors in the mechanism of the solar atmosphere, but also can and do appear in all solar latitudes, might be directly responsible for these changes of form of the corona.

The crucial test resolved itself into demonstrating that the epochs of the occurrence of all those forms of the corona which exhibited streamers at or near the solar poles should be coincident with those epochs when prominences were known to be in very high latitudes. To do this it was necessary to study all the trustworthy data relating to the more modern records of solar activity.

It is well known that the area or number of the spots on the sun varies from year to year, and that about every eleven years or so this number reaches a maximum value. This cyclical change of spotted area is shown at the top of Fig. 3. Sunspots are not formed on all parts of the solar

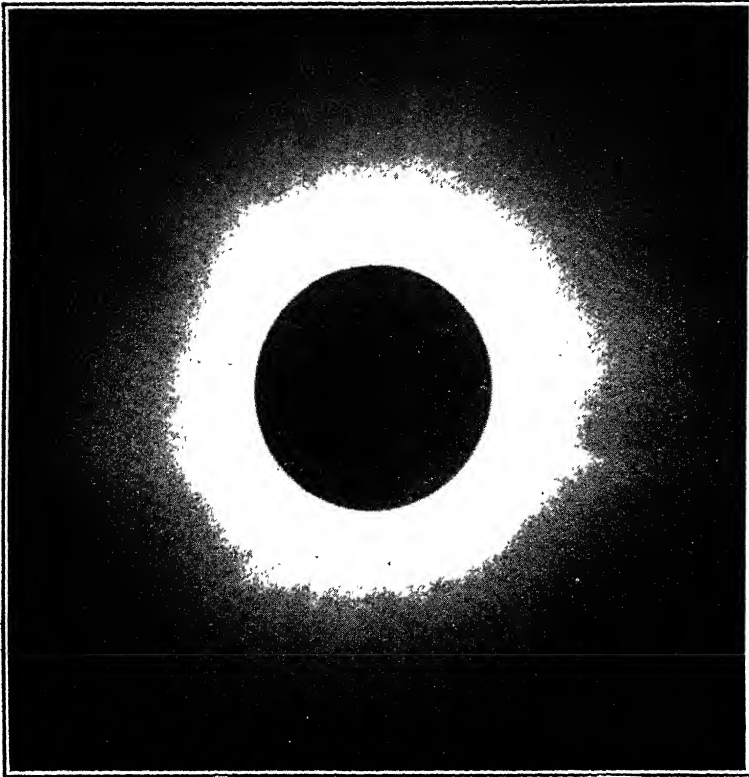


FIG. 1.—Solar corona, Aug. 30, 1905. Maximum type. Exposure 20 sec. By C. R. Davidson. By permission of the Astronomer Royal.

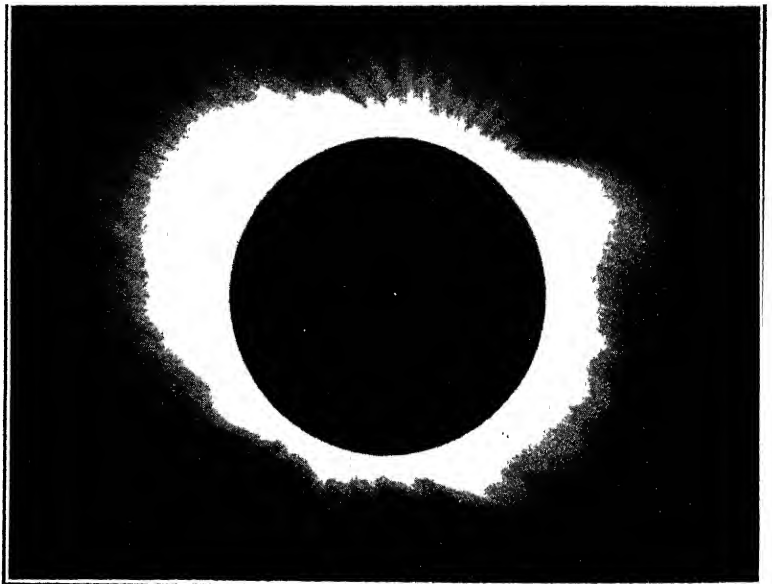


FIG. 2.—Solar corona, May 28, 1900. Minimum type. Exposure 30 sec. By E. E. Barnard.

To illustrate the striking difference between the extent of latitudes covered by spots and promi-

nences, the accompanying diagram (Fig. 4) has been made showing this distribution for the years 1892, 1893, and 1894, the year 1893 being a year of sunspot maximum.

The central vertical line represents the solar equator or latitude 0° , and the black areas on each side of it indicate the areas of prominences for each of the three years (all drawn to the same scale) plotted for every five-degree zone of latitude on the scale given at the bottom for both north and south solar latitudes. It will be seen that pro-

compared with that of the prominences, and in the second place, that the zones of maximum spotted area, in these years about sunspot maximum, lie within 20° of latitude on either side of the equator.

A study of the fourth series of curves in Fig. 3 shows that when prominences are at their maximum frequency they occur in two zones, the mean yearly latitudes of which are about 70° and 25° . When they are fewest in number their mean yearly latitude is about 40° . This cyclical change of latitude from year to year is shown in the diagram.

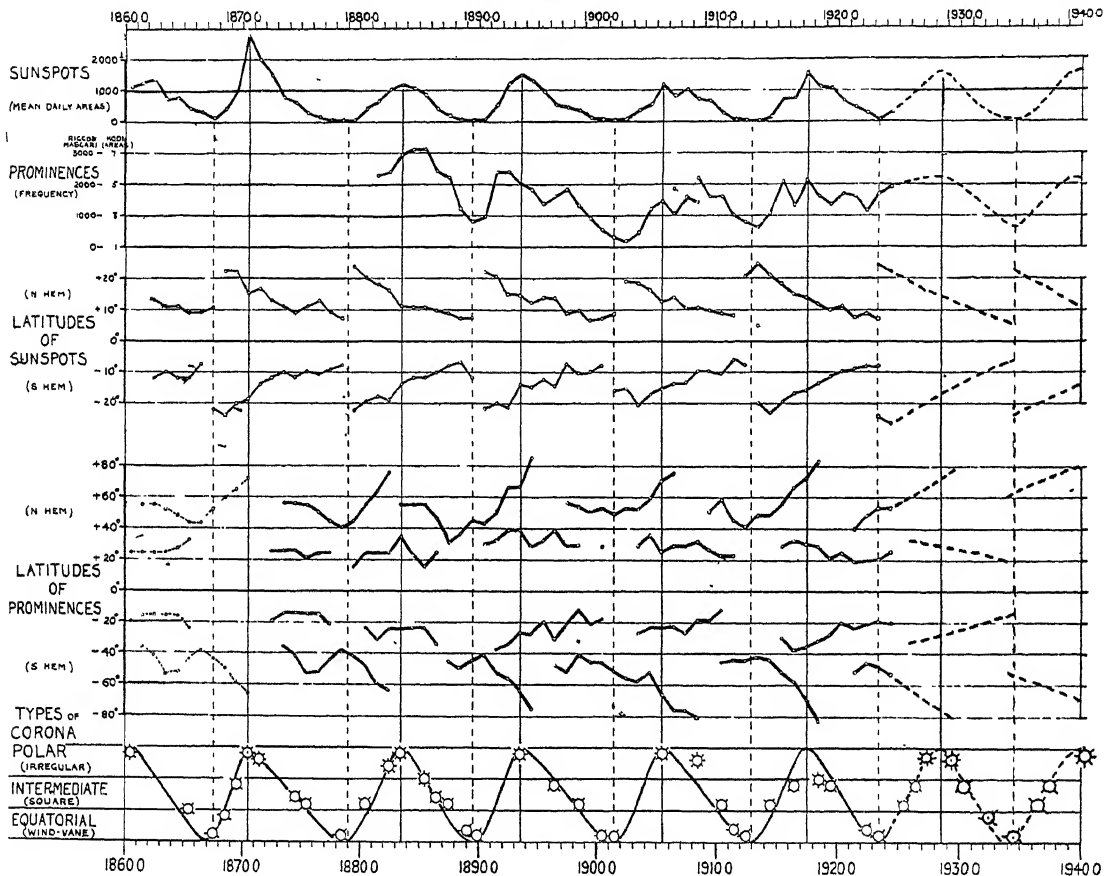


Fig. 3.—Diagram showing the relationship between the different forms of the corona and the latitudes of prominences.

minences are distributed in all solar latitudes in these years, and in some cases are very pronounced in high solar latitudes in both hemispheres, as indicated by the pronounced peaks in the area curves.

The smaller white areas represent the areas of sunspots for the same years. They are all drawn to the same horizontal scale as regards latitude distribution as the prominences, but the vertical scale for their areas, while the same amongst themselves, is different from that of the prominences.

The diagram clearly shows, in the first place, the insignificant distribution of the spots in latitude

Thus while the epochs of sunspot and prominence maxima are practically coincident, the spots at these times are most active in latitude about 18° , while prominences exhibit their greatest activity in about latitudes 70° and 25° .

Now from the prominence curves for both hemispheres it is quite easy at a glance to distinguish the years when these phenomena attain high latitudes, such as 60° or more. The question is, do these years pick up those cases in which the corona has been observed, and described as of 'polar,' 'irregular,' or 'maximum' type?

To answer this question easily, the various forms

of the corona, as recorded by different eclipse observers since the time of routine prominence observations first began, namely, in the year 1872, are brought together at the bottom of Fig. 3. Thus, for example, all the forms termed 'polar' are placed in the first horizontal strip in their respective years of observation according to the time-scale indicated at the bottom. All those designated 'intermediate' and 'equatorial' are also placed in lower strips at their observed years. It is found that a curve can be drawn through them

peaks in either hemisphere at those latitudes, but only a gradual reduction in area from the prominent peaks in latitudes 25° north and south. There were therefore high latitude prominences in that year, so that 1883 is no longer an exception as expressed above.

It is important to point out further that there is no case of an 'equatorial' or 'intermediate' form of corona being recorded when the prominences were in high latitudes.

The deduction to be made is, therefore, that it is only when prominences are near the solar poles that coronal streamers will be found there. This fact points clearly to the conclusion that prominences are the prime factors in the formation of coronal streamers.

Limitations of space permit one only to mention here the fact that there is a mass of other evidence which can be brought to bear to show the close association of prominences with coronal forms, as, for example, the arch-forms of coronal matter so often recorded as being directly situated over large prominences, in spite of the fact that the material of which prominences are formed is quite distinct from coronal matter.

A more detailed study of the diagram shows that while prominences near the solar poles are responsible for the 'polar' or 'irregular' types of the corona, the 'intermediate' forms owe their origin to the presence of two zones of prominences, and the 'equatorial' forms to one zone in each hemisphere.

The rhythmic nature of all the curves, as shown by the continuous lines, suggests that they can be continued for a few years without any great error. This has been done in Fig. 3 by means of broken lines¹ up to the year 1940, and below them are forecast the various forms of the corona which may be expected in future eclipses up to that year, based principally on the probable prominence curves. The corona of the present year should therefore be 'polar' or 'irregular,' corresponding to a very disturbed state of the sun's atmosphere. It should thus be irregular in form, devoid of pronounced polar rifts, and should be very bright. It may exhibit long streamers in any solar latitude. Its brilliancy will probably prevent any but the brightest stars from being seen, but on the other hand it lends itself very favourably to special studies of its composition by means of the spectroscope.

¹ There have just been published the latitudes of the mean areas of prominences for the first half of the year 1926. This shows that the zones of maximum area lie at latitudes 40° and 70° in the northern and 38° and 60° in the southern hemisphere, thus closely endorsing the points forecast in Fig. 3 for that year.

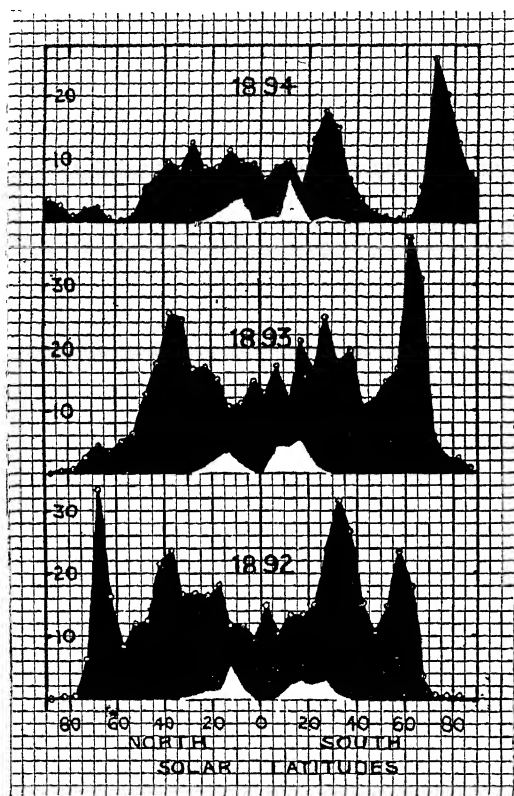


FIG. 4.—Diagram showing the distribution in latitude of prominences (dark areas) and sunspots (light areas) for the years 1892-94 (sunspot maximum 1893).

approximately resembling the sunspot and prominence curves at the top of the figure. Thus it is seen that the forms of the corona follow one another in the following sequence, namely, polar, intermediate, equatorial, intermediate, polar, etc.

Comparing these coronal types with the curves immediately above them, it is fairly obvious that 'polar' forms are coincident with 'high latitude' prominences in every case except one, namely, in the year 1883. A re-examination of the prominence data for that year discloses the fact that their presence was recorded up to latitude 65° in the northern and 75° in the southern hemisphere; the yearly curve did not, however, exhibit distinctive

The Moon's Shadow in Relation to the Earth on June 29.

By Dr. E. H. RAYNER.

THE shadow of the moon, considered as a slightly conical cylinder about 240,000 miles long, intersects the earth at Cardigan Bay at 5^h 23^m G.M.T. At this moment the imaginary point of the shadow is about 1500 miles within the earth. The average diameter of the shadow as it crosses England is about 15 miles where it intersects the earth, being the value of the minor axis of the elliptical area of the earth's surface within which the eclipse is total at any moment. The altitude of the sun being about 11°, the major axis of the ellipse is four to five times as long as the minor axis. The azimuth of the sun is some 20° to the south of the direction of the shadow track; and this, combined with the elliptical form, causes the width of the track of totality to be about twice the diameter of the shadow cone.

The accompanying illustration (Fig. 1) shows a model of the conical shadow at 5^h 23^m. The scale of the model is 10 miles to the inch, which is that of the special Ordnance Survey Map. It will be seen that the centre line of the shadow crosses the east coast of England over south Yorkshire at a



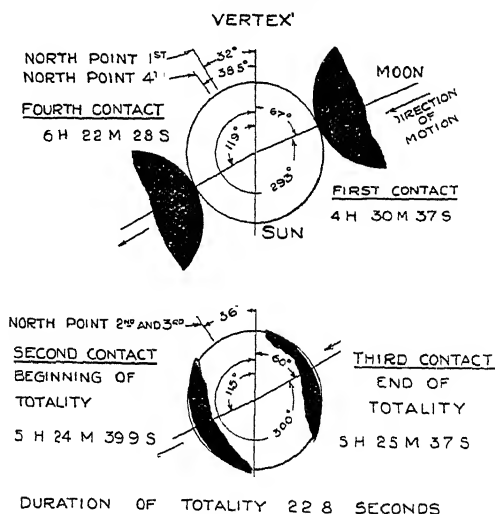
FIG. 1.—Three-dimensional model of shadow of the moon near the earth's surface.

on behalf of the Radio Research Board, to whom



FIG. 2.—Position and orientation of England during the eclipse.

height of about 45 miles. An important height from the point of view of radio transmission is about 100 kilometres, or 60 miles. The intersection of the centre of the shadow with this level has therefore passed over England towards the east



TIMES OF CONTACT AND POSITION ANGLES
FOR LAT. 54° 24' N 1° 45' W. BEING THE POSITION.
OF THE S W CORNER OF RICHMOND RACE COURSE

FIG. 3.—Circumstances of the eclipse for Richmond, Yorkshire.

I am indebted for much of the information of numerical character.

Over England the plan position of the intersection at 60 miles high runs nearly parallel to the 0.98 totality line to the south of the central track. It is for most of the distance between the Bristol Channel and the North Sea, within 2 to 5 miles of this line and to the south of it. The location at 5^h 20^m is shown in the lower margin of the illustration, and that at 5^h 22^m is near the east coast. It is interesting to note that according to the data used in the computation, the centre of the shadow has not reached the earth's surface at 5^h 20^m, its nominal time of contact being 5^h 20.1^m.

The season and the early time of day at which the eclipse takes place, being before 6 A.M. by solar time for first, second, and third contacts, causes the lines indicating simultaneous maximum phase on the map to be displaced more than 90°

from the lines of longitude to which they approximate later in the day where the eclipse takes place at local noon. The map (Fig. 2) shows the shape of England as viewed in the direction of the shadow axis, the plane containing the earth's axis being imagined to indicate the vertical.

Arrangements have been made for the party organised by the Physical Society of London to have the use of accommodation at the Race Course at Richmond. The times of the contacts and position angles are shown in Fig. 3. The computation has been made taking into account the corrections given by Dr. Comrie, as a result of the information recently provided by the Astronomer Royal. The difference between the position angles of second and third contacts, 185°, being larger than 180°, shows that the point is a few hundred yards to the north of the centre line.

Astronomical Programmes of Eclipse Work.

By F. J. M. STRATTON.

ALTHOUGH the Joint Permanent Eclipse Committee has organised no special expedition to observe the eclipse of June 29, it has arranged that all instruments in its charge should be employed at the eclipse and has acted as an intermediary in securing instruments and local facilities for various expeditions. Ready co-operation has been invariably met with locally.

The first eclipse camp on the track of which the programme details are available is at Llysfaen Head, near Colwyn Bay. Here Dr. R. J. Clark, of the University of Edinburgh, Prof. H. Dingle, of the Imperial College of Science and Technology, South Kensington, and a group of research students from the University of Cambridge, will be stationed. A 16-inch coelostat will be used to feed two spectrographs—a slit spectrograph working with a very dense flint Parsons prism, and an objective grating-spectrograph using a parabolic grating lent by Mr. Merfield of Melbourne, especially ruled to be strong in the infra-red of the first order and the ultra-violet of the second order. Abney plates will be used, and it is hoped to extend the spectrum of the chromosphere, and if possible of the corona, well beyond $\lambda 10,000$. Wireless experiments on the strength of signals will also be carried out. Prof. Nolan from Dublin will also be at Colwyn Bay studying atmospheric electricity during the eclipse, and possibly President Morehouse from Des Moines University, Iowa, may be there with a spectroscopic programme.

Where the eclipse track strikes land again at Southport, the Oxford expedition under Prof. H. H. Turner and Dr. H. Knox-Shaw will be stationed. Their programme consists of direct photography of the corona together with photographs in polarised light. At Stonyhurst, Father O'Connor will also be taking direct photographs of the corona and flash spectra, working so far as possible into the

infra-red. It is understood that Prof. da Costa Lobo, Director of the Coimbra Observatory, Portugal, will be at Stonyhurst with a cinema camera and spectroscopic apparatus.

The expedition from the Royal Observatory, Greenwich, will be in the grounds of Giggleswick School, near Settle. Its programme consists of direct photographs of the corona with a 6-inch lens of 45 ft. focal length, the spectrum of the chromosphere in the extreme red and a comparison of the intensities and heights of H and K and of the Ca⁺ triplet $^2D - ^2F$ at $\lambda\lambda$ 8498, 8542, 8662.

Mr. Evershed will be at Tunstall, about five miles from the central line, working with a large prismatic camera with two 6-inch prisms of 45° angle and a lens of 21 ft. focus. He will be studying the cusp spectrum before and after totality and the flash spectrum, and will be largely concerned with the height of the various gases. The Norman Lockyer Observatory expedition will be between Gilling and Richmond with a programme of direct photographs of the corona and small-scale spectra. Other observers who are expected to carry out observations in the belt of totality in Great Britain include Mr. Albert Taylor at Llanbedrog, Prof. E. A. Owen at Bangor, Mr. Harold Thomson and Mr. F. Sargent, of the Observatory of Durham, at Catterick, Dr. F. W. Aston and Mr. Wilfrid Hall also in Yorkshire. Prof. A. Fowler at the Imperial College of Science and Technology, London, and Prof. R. A. Sampson at Edinburgh, are proposing to study the cusp spectrum with high dispersion spectrographs during a considerable interval on either side of the time of maximum eclipse.

The other British expedition is that of the Solar Physics Observatory, University of Cambridge, which proceeds under Prof. H. F. Newall to Aal, in the Hallingdal in Norway. In addition to direct

photographs of the corona the programme includes spectroscopic observation of the chromosphere in the ultra-violet and the infra-red, with special application to the relative intensities of the red calcium triplet and of H and K. The intensities of lines at different heights will also be studied. Spectrophotometric work will figure largely in the programme, and there will also be polariscopic observations and interferometer photographs of the corona.

The American expeditions are all, except that of President Morehouse, to be stationed in Scandinavia. Prof. H. T. Stetson, of Harvard Observatory, and Mr. Weld Arnold, will be doing photometric work on the total brightness of the corona at Fagernas, where Prof. S. A. Mitchell, of the Leander McCormick Observatory, will also be stationed. Farther north, possibly near Gellivare, will be the Dutch expedition, including Dr. Minnaert, with

the spectrophotometric programme which they were prevented by clouds from carrying out in Sumatra last year. Dr. Luyten will accompany this party. In addition to Prof. Stetson's photometer and the Dutch instruments, it is understood that Dr. Anderson's eclipse spectrograph, which was also blocked by bad observing conditions in Sumatra, will again be brought into use, in the hands of Dr. S. Rosseland. Finally, an Italian expedition under Prof. Horn d'Arturo may be stationed in Norway, and it may be assumed that there will be several Scandinavian expeditions and German expeditions in Scandinavia also. Details of their plans have not come to hand.

Nowhere along the track can it be said that weather prospects are very good. On the other hand, they are not so bad that we may not expect fairly confidently results of value from some of the many expeditions that will be observing the eclipse.

Observing Parties and Stations.

THE NORMAN LOCKYER OBSERVATORY.

DR. W. J. S. LOCKYER, director of the Norman Lockyer Observatory, informs us that the expedition from the Observatory will occupy a site on the eastward and adjoining side of a good road connecting Richmond with Gilling village, and distant one mile from the market place of the former town. It is on the Marquess of Zetland's estate, and he has very kindly given permission for the Observatory's party to take up its position there. The site is situated on a 600-foot contour line, and looking away from it towards the north, through the east and to the south, the ground falls away sharply at first and gradually afterwards. In fact, there is no land reaching anywhere near 600 feet within twenty miles of a line drawn due east and twenty-five miles a little north of east.

The programme of work to be attempted at Richmond is to secure large- and small-scale photographs of the corona, chromosphere, and prominences, and also a photograph of the spectrum of the corona.

The conditions of the eclipse are not sufficiently favourable to warrant the transport of a large spectrograph for photographing the chromosphere at second and third contacts. As such photographs can be obtained at stations where the partial phase is very large, arrangements have been made to accomplish this at the Sidmouth Observatory, where a large spectrograph is available.

Time determinations of the contacts will also be attempted, use being made of the broadcast time signals for checking the rate of the chronometer. The large-scale photographs of the corona will be taken with a camera the lens aperture of which is 6 inches, having a focal length of 31.5 feet, giving a solar image 3.3 inches in diameter. This instrument will be rigidly oriented to the eclipsed sun, the photographic plate only being moved by mechanism. One exposure only will be made.

Two smaller coronagraphs will in addition be

mechanically driven, one having a 6-inch aperture and 4 feet focal length and mounted equatorially, and another a $3\frac{1}{2}$ inch Dallmeyer rectilinear lens of 15 inch focal length mounted on a 12-inch siderostat. One plate will be exposed in the latter and two or more in the former.

Four or more other coronagraphs from 4 inches aperture or less, including a Zeiss triplet aeroplane lens working at f 4.8 and an Aldis triplet aeroplane lens working at f 5.6, will be fixed in position, and two or more plates will be exposed in each, with exposures of two seconds or less.

The large-scale photographs of the chromosphere and prominences will be taken with a 30-foot coronagraph, giving an image of about 3 inches. This instrument will be fixed in the direction of the eclipsed sun, and the exposures given will be very short. Altogether about eight exposures will be attempted.

To secure the spectrum of the corona on a small scale, a Thorp transparent grating mounted in front of a Zeiss triplet aeroplane lens working at f 4.8 will be used. This instrument is mounted on the upper end of the polar axis of a 12-inch siderostat and is clock-driven. One exposure only will be made of the coronal spectrum in the first order of the grating.

The party from the Norman Lockyer Observatory will consist of Lieut.-Col. Sir Francis McClean, Capt. W. N. McClean, and Dr. W. J. S. Lockyer, but much additional volunteer assistance will also be available to manipulate several of the smaller instruments and undertake other observations.

ROYAL OBSERVATORY, GREENWICH.

THE headmaster of Giggleswick School has kindly placed a field at the disposal of the Greenwich expedition. The observing party will consist of the Astronomer Royal, Dr. Jackson, Mr. Davidson, Mr. Melotte, and Mr. Woodman. Three different observations will be attempted.

(1) A large-scale photograph of the corona will be taken. For this a 6-inch lens of 45 ft. focus,

kindly lent by Mr. Worthington, will be used. This gives an image of the sun 5 inches in diameter. There is only time for one exposure of approximately 20 seconds.

(2) With a spectroscope of Littrow type, using a prism of 40° angle and 7 inches in height and a lens of $11\frac{1}{2}$ ft. focus, the spectrum of the chromosphere in the red and infra-red will be photographed. Plates dyed with dicyanin will be used, and the spectrum will extend from the magnesium triplet in the green well into the infra-red.

(3) Prof. Milne has shown the importance of a photometric comparison of the H and K lines in the chromosphere; that is, the doublet $1^2S - 1^2P$ of ionised calcium, with the calcium lines at $\lambda 8498$, 8542 , and 8662 ; that is, the doublet $1^2D - 1^2P$ with its satellite. A spectroscope of reflecting Littrow type has been arranged to give these lines on the same plate. Neocyanin plates recently introduced by the Kodak Company will be employed. By the use of a coarse grating on the solar spectrum the intensity scale will be determined for different parts of the spectrum.

The times of beginning and end of totality will be observed with a direct-vision spectroscope on a 3-inch telescope.

UNIVERSITY OF OXFORD.

THE expedition to observe the eclipse at Southport, on the cordial invitation of the Mayor and Corporation, will be a joint expedition from the University and Radcliffe Observatories, Oxford, arranged by Prof. H. H. Turner and Dr. H. Knox-Shaw in collaboration.

The astrographic object-glass of the University Observatory, fitted to a temporary mounting used previously in Egypt in 1905, and pointed to the 16-inch coelostat, recently purchased from the Royal Society, will be used to take two or three photographs of the corona. (The purchase of the coelostat, and its renovation, were rendered possible by timely grant from the trustees of Lord Leigh's Fund.) In addition, two photographs will be taken in light polarised in planes at right angles by means of reflection from plane glass plates blackened on the back: the lenses are the similar components which made up the Abney lens used in many eclipse expeditions, and the reflecting plates will be placed near and within the focus. These two cameras will be mounted equatorially.

During a preliminary visit last January, when the kind help and advice of Mr. C. Davidson, of the Royal Observatory, Greenwich, were available, the site for the observations was fixed in the grounds of King George V. School, on the invitation of the headmaster, Mr. G. A. Millward, who has also

extended his hospitality to 100 boys who will come from London under the care of the *Daily News*.

STONYHURST COLLEGE.

At Stonyhurst College arrangements are being made by Father O'Connor, director of the Observatory there, to take direct photographs of the corona with the 4-inch coronagraph lens belonging to the Royal Irish Academy, of 19 ft. focal length, a 6-inch Dallmeyer portrait lens of about 30 inches focal length, and a Dallmeyer telephoto lens.

An attempt will be made to photograph the corona with the 15-inch equatorial, using a green screen with maximum transparency at $\lambda 5300$.

Flash spectra, as far into the red as possible, with the 19-ft. lens used as a prismatic camera, will also be attempted.

With the Hilger spectrograph, work will be carried out on the cusps before and after totality.

Quick runs on the magnetographs, and meteorological observations during the course of the eclipse, will complete the Stonyhurst official programme.

SOLAR PHYSICS OBSERVATORY, CAMBRIDGE.

THE altitude of the sun will not exceed 13° in any site in England at the time of the total phase, and accordingly the conditions in Norway were investigated. It was found that the altitude will be nearly twice as great in Hallingdal and the neighbouring valleys, and the local conditions thereabouts were examined. Prof. Newall and Mr. Carroll went over to Norway in September for three days, and had the great advantage of enlisting the kind help of Prof. V. Bjerknes, who met them at Aal (Hallingdal) on the railway between Bergen and Oslo. Here, after considerable exploration, a site was found in all respects convenient, though, as had been anticipated, the difficulty in that rocky and wooded region was to find a level site which was not already occupied by a house or a farmstead.

The observations which will be aimed at are the following:

Spectroscopic observations of the chromosphere in the ultra-violet (Prof. Newall). Spectroscopic observations of the red calcium lines in the chromosphere, high dispersion, and of both red and violet calcium lines in the chromosphere, low dispersion (Mr. Carroll and Mr. Stratton). Spectroscopic observations with objective grating and moving photographic plate (Mr. Butler). Photometric work in connexion with each of the above. Interferometer observations of the corona (Prof. C. Bryant). Large-scale coronagraph photographs (Mr. W. M. Smart). Polariscopic observations of the corona (Prof. Newall).

